

**I-CHOOSE U: DEVELOPMENT OF DECISION SUPPORT SYSTEM
USING SKYLINE TECHNIQUE (PREFERENCE QUERY
TECHNIQUE): THE CASE OF CHOOSING MALAYSIAN HIGHER
LEARNING INSTITUTIONS**

Omer Ibrahim Elkhder Elhassan

UNIVERSITI UTARA MALAYSIA

2011

**I-CHOOSE U: DEVELOPMENT OF DECISION SUPPORT
SYSTEM USING SKYLINE TECHNIQUE (PREFERENCE
QUERY TECHNIQUE): THE CASE OF CHOOSING
MALAYSIAN HIGHER LEARNING INSTITUTIONS**

A project submitted to the Dean of Awang Had Salleh Graduate
School in partial Fulfillment of the requirement for the degree of
Master of Science (Information Technology)
Universiti Utara Malaysia

By

Omer Ibrahim Elkhder Elhassan
(807001)

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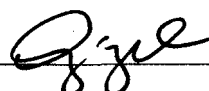
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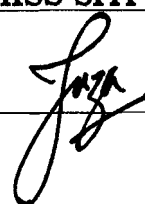
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(Name of Supervisor) : **DR. AZIZAH HJ. AHMAD**

Tandatangan
(Signature) :  Tarikh (Date) : 26/6/11

Nama Penilai
(Name of Evaluator) : **MISS SITI MAHFUZH SARIF**

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ABSTRACT

This study focuses on Malaysian public universities marketing strategies which mainly used to attract international students who have the intention to enroll in higher learning institutions in Malaysia. The main objective of this study is to develop decision support system prototype (DSS) using preferences queries technique (skyline technique), in order to solve the issue of facing challenges that can be consequences of wrong selection of universities or colleges that had been made by students and may influence in their performance. This system aim to help international students to choose suitable college based on their criteria as well as to help them to make the right decision when they want to select one of the public universities in Malaysia. In this research; we used rapid application development (RAD) method. The DSS prototype (i-choose u) in this study constructed by using Java Server Pages (JSP) and MYSQL for database development, which are open sources software. The DSS prototype (i-choose u) suggests maximum five universities to international students that are most suitable to students based on student's criteria.

ACKNOWLEDGEMENT

All praises and thanks are to Allah, the Lord of the 'Alamin'

First, I would like to express my gratitude to my supervisor, Dr. Azizah Bt Haji Ahmad for her expertise, guidance and encouragement, which ensure that progress of this study was continuously maintained. Our discussions have contributed to the completion of this work.

I would also like to express my thanks to the University Utara Malaysia, especially to lecturers and my colleagues of the Faculty of Information Technology, for the enjoyable working environment, and for their support.

Last, but not least, I would like to thank my father, Dr. Ibrahim Elkhder and my mother, Mwahib Abd Alhalim for their endless encouragement, also my brothers, my sisters, my uncles, my aunts, my brothers in law, my nephew, my niece and all the people close to myself, for their strong support, encouragement, friendship and love.

Sincerely Grateful

Omer Ibrahim Elkhder

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CHAPTER ONE

INTRODUCTION

Selecting a higher learning institution (HLI) is a crucial decision that may shape the life and success of a student's career. There are many important criteria that have a strong influence on international students' decision-making process such as: quality of learning environment, customer focus, cost, facilities, socialization and location. A study concluded that customer focus and facilities are the main criteria used by respondents in their decisions (Padlee & Kamaruddin, 2010).

These factors should be considered by colleges to develop their marketing strategies in attracting foreign students to enroll at their institutions. It is also important for positioning strategy and strengthening HLI offerings to the foreign market (Padlee,S & Kamaruddin, 2010).

1.1 Background

Malaysia is a fascinating and enchanting nation of different races, cultures and religions, co-existing in harmony in a tropical paradise in the heart of Southeast Asia. Malaysia comprises two distinct land areas, West Malaysia and East Malaysia. West Malaysia is a peninsula, flanked by the South China Sea on the east and the Straits of Malacca on the west, with Thailand as its northern neighbour and Singapore sitting at the south. West and East Malaysia cover a total land area of about 329,758 km² and are separated by approximately 40 miles of sea.

East Malaysia consists of a Federal Territory and two large states, namely Sabah and Sarawak, which occupy the northern area of Borneo Island. West Malaysia consists of eleven States and two Federal Territories, all of which have their own distinctive attractions (Study abroad in Malaysia, 2010).

Malaysia has a number of international students enroll in either private or public college in allover the country. There ara several criteria to consider by both students and their parents when deciding on the place and major of study. In choosing Malaysia as a study destination, students benefit from:

- An international standard of high quality education, which is closely monitored by the Ministry of Higher Education Malaysia through the quality control authorities and appropriate legislation such as the Education Act 1996, the Private Higher Educational Institutions Act 1996, the Universities and University Colleges (Amendment) Act 1996 and the Malaysian Qualifications Agency Act 2007.
- Competitive course fees and an extensive selection of popular courses.
- A wide range of study options and universities or colleges to choose from.
- Twinning and 3+0 degree programs conducted in Malaysia, which offer a cost-effective route for quality education and foreign qualifications from universities in the UK, USA, Australia, Canada, New Zealand and France.
- Foreign University Branch Campuses operating in Malaysia, which enable students to acquire their prestigious university qualifications in a country that has lower living expenses.

- Wide usage of English, which makes living and studying easy for students who are proficient in English, while at the same time creating an environment for those who want to pick up the language.
- Life in a multi-cultural society, where Malaysians of different races and religions live in peace and tolerance with each other.
- The experiences gained in providing education to the existing 70,000 international students from more than 100 countries, which testifies to the world-wide acceptance of Malaysia as a favoured destination for further studies.
- Simple immigration procedures, which enable foreign students to have easy entry into Malaysian higher educational institutions.
- Affordable living expenses, which can be as low as RM12,000 (USD3,430) per year.
- Student-friendly laws, which allow international students to work part-time for a maximum of 20 hours per week, while studying full-time in Malaysia (subject to immigration requirements).
- An economically sound and socially safe country, which has a stable government and a low serious crime rate.
- A geographically safe environment, with Malaysia situated in a zone free from most natural disasters.
- A food paradise which has a huge variety of cuisines available including vegetarian, halal, ethnic and Western.
- An excellent transportation system, which allows easy mobility and a variety of interesting places to visit for relaxation.

An important result of Malaysia's carefully managed modernization is a steadily improving education system that has poured millions into research and development to encourage international students into the country. In the 2010 QS World University Rankings, five universities appeared in the QS Top 500. The quality of teaching in institutions like Universiti Malaya (UM), Universiti Kebangsaan Malaysia (UKM) and Universiti Sains Malaysia (USM) has improved greatly over recent years, following a government decree that all teachers and lecturers have to possess a degree in the subject that they are teaching, which was not the case before the turn of the century (Study abroad in Malaysia, 2010).

Generally, the flow of international students in Malaysia has increased steadily since 1996, when various higher education reforms were introduced to facilitate the entry of international students into higher education institutions. Malaysia's target is 100,000 international students by 2010. Currently, international students represent less than 5 per cent of all tertiary enrolments in Malaysia. Although the percentage is small, it is an important factor in the internationalization of higher education in Malaysia (Mahmuda, 2010). The impact of September 11 has seen a decreasing number of new applications from Middle Eastern countries to the United States (US). While students from these countries were reluctant to go to the US for their education, the US government-mandated changes in the admissions process themselves have contributed to the decrease in new enrolment. Interestingly, Malaysia has emerged as an important destination for students from the Middle East. Malaysia provides excellent education and adequate security.

They feel safe in Malaysia. Realizing these emerging opportunities, the government has organized seminars and exhibitions annually in the Middle East with a view to encouraging more enrolment (Sirat, 2008).

1.2 Problem Statement

There are many challenges faced by international students in Malaysia. A number of studies stated that international students experience challenges adjusting to food, weather, financial arrangements, health care, accommodation and local language, while financial and language limitations add to the difficulties for the newcomers (Tseng & Newton, 2002; Lin & Yi, 1997; Poyrazli & Grahame, 2007). These challenges can be the consequences of the wrong choice of universities or colleges made by students and may influence the students' performance. The Malaysian universities offer information for international students by using their own web sites, but most of these web sites don't have facilities to help them to make the right decision according to their unique criteria (Mahmuda, 2010 ; Maltz, Murphy, & Hand, 2007).

In order to solve this issue, this study attempts to develop a decision support system (DSS) for public universities in Malaysia using preference query techniques. The system will help international students to choose a suitable college based on their criteria, such as the information of courses, culture, location, and language, type of accommodations and cost to help them make the right decision when they want to enroll in universities in Malaysia.

1.3 Research Questions

- What are the criteria for choosing public universities in Malaysia?
- How can Preference Query Techniques be used in developing a DSS prototype for international students in choosing the right universities?
- How to develop a DSS prototype for international students to help them in choosing the right university in Malaysia?

1.4 Objectives

The main objective of this project is to develop a DSS prototype for students to help them choosing the right universities in Malaysia by using preference query techniques. To achieve the main objective, this study first has to carry out the following sub-objectives:

- a) Identify criteria for choosing universities in Malaysia.
- b) Model the DSS requirements based on Preference Query Techniques.
- c) Design and develop a DSS for choosing the right universities.

1.5 Scope of the Study

In this research, the DSS prototype will help international students to choose Malaysian public universities to help them to choose Malaysia as a destination when they want to study abroad. In our database we inserted Information Technology for PhD and master degree and Management for undergraduate for public universities in Malaysia.

The Preference Query Technique help students to choose a college in Malaysian public universities based on student criteria. In this research, we used skyline techniques. The system will display maximum five suggested universities for every student who inserts criteria.

In this research, we developed the web-based DSS prototype by using Java Server Page (JSP) for web pages programming and MySQL for Database (open source software).

1.6 Significance of the Study

This study provides significance for many parties, such as international students, public Malaysian universities and the Ministry of Higher Education in Malaysia.

The international students have to select universities based on their criteria to make sure that they will continue in their studies and will not face challenges that can affect their performance. The results that come from their search will be in order by using the preference query techniques.

Malaysian universities should improve services to compliment the high quality campus infrastructure. Efficient international offices, multicultural trained student personnel, and support programs built for international students will help improve services for international students.

The Ministry of Higher Education in Malaysia wants to increase the number of international students for public Malaysian universities, so by providing a decision support search engine prototype in order to help international students to choose

the right universities based on their criteria will lead and encourage more international students to study in Malaysia and increase their possibility of success in their studies.

1.7 Thesis Organization

Chapter two will talk about the DSS and preference query techniques. Moreover, we will talk about Malaysian public universities. On the other hand, Chapter three is considered as the descriptive part, illustrating the DSS life cycle methodology that I used in my project. Chapter four is the presentation of the analysis, design and implementation of the DSS prototype. Chapter five presents the conclusions and highlights certain suggestions for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The decision support system has gone through several stages. In the early 1960s the DSS began with building of the model-driven DSS. In the 1970s the DSS theory was developed during the implementation of financial planning systems, spreadsheet DSS, and in the early 1980s and the mid-90s, the Group DSS, Data warehouses, Executive Information Systems, OLAP and Business Intelligence appeared. The final stage of DSS was in the mid-90s by development of the knowledge-driven DSS and the implementation of Web-based DSS (Power, 2003). Furthermore, in the early 1970s and 1980s, the decision support systems (DSS) grew and developed out of two previous types of computer support for decision-making. The first contribution to support decision-making was in operations research/management science (OR/MS), which used mathematical models to analyze and understand specific problems. The second was management information systems (MIS), which provided (1) the ability to query a database for specific data, (2) demand reports for ad hoc information requests, and (3) scheduled reports for well-defined information needs. Therefore, there are many definitions of decision support systems (Kopackova& Skrobackova, 2005).

2.2 Definitions of Decision Support System

A decision support system is a computer system designed to provide assistance in determining and evaluating alternative courses of action. In addition, a DSS gets the data from the organization's everyday data transactions, analyzes it to extract significant information, and narrows down the range of choices by applying rules based on decision theory. Its objective is facilitation of 'what if' analysis and not replacement of a manager's judgment (Barger, 2008). Decision Support System is a computerized information system that supports business and organizational decision-making activities. A properly designed DSS is interactive software-based systems proposed to aid decision-makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions (Boreisha & Myronovych, 2009). A decision support system (DSS) is a computer program application that analyzes business data and presents it so that users can make business decisions more easily. It is an informational application that collects the data from the course of normal business operation (Kopackova& Skrobackova, 2005).

2.2.1 Applications of Decision Support Systems

Decision support concepts have evolved from two main areas of research: the theoretical studies of organizational decision-making done at the Carnegie Institute of Technology during the late 1950s and early 1960s, and the technical work on interactive computer systems, primarily carried out at the Massachusetts Institute of Technology in the 1960s. It is considered that the concept of DSS became an

area of research of its own in the middle of the 1970s, before gaining in intensity during the 1980s. In the middle and late 1980s, executive information systems (EIS), group decision support systems (GDSS), and organizational decision support systems (ODSS) evolved from the single user and model-oriented DSS (Tunban, Aronson, Liang & Sharda, 2007).

As mentioned above, there are theoretical possibilities of building a DSS in any knowledge domain. For example, in engineering, Kosavinta, Kanongchaiyos and Jinuntuya (2007) had built a DSS prototype for engineering and Architectural Project Design to help them to manage their project, which allowed users to either manage their project with the estimated change of design or design the product and estimate the result for supporting their decision. Moreover, DSS had been applied in medicine, where Martin, Samson & Mark (2001) developed a DSS prototype to display patient-specific treatment information at the point of care, and allowed a clinician to modify patient data and fetch updated advisories, or to request an explanation for any recommendation.

2.3 Types of Decision Support Systems

Decision Support Systems have several types, which can be categorized as Data driven DSS, Model driven DSS, Knowledge driven DSS, Document driven DSS, Communication driven DSS and Web-based DSS (Tunban, Aronson, Liang & Sharda, 2007).

2.3.1 Data-driven DSS

Data driven DSS are targeted at managers, staff and also product/service suppliers. It is used to query a database or data warehouse to seek specific answers for specific purposes. It is deployed via a mainframe system, client/server link, or via the web. Data-Driven DSS emphasize access to and manipulation of large databases of structured data, and especially time-series of internal company data and sometimes external data (Kopackova & Skrobackova, 2005).

2.3.2 Model-driven DSS

Model driven DSS is a system that uses accounting and financial models, representational models, and optimization models. Model driven DSS emphasize access to and manipulation of a model. Simple statistical and analytical tools provide the most elementary level of functionality (Kopackova& Skrobackova, 2005).

2.3.3 Knowledge-driven DSS

Knowledge driven DSS can suggest or recommend actions to managers. These DSS are person-computer systems with specialized problem-solving expertise. The expertise consists of knowledge about a particular domain, understanding of problems within that domain, and skill at solving some of these problems. A related concept is Data Mining. It refers to a class of analytical applications that search for hidden patterns in a database. Data mining is the process of sifting through large amounts of data to produce data content relationships. Data mining

tools can be used to create hybrid Data-Driven and Knowledge-Driven DSS (Kopackova & Skrobackova, 2005).

2.3.4 Document-driven DSS

Document driven DSS integrates a variety of storage and processing technologies to provide complete document retrieval and analysis. The Web provides access to large document databases, including databases of hypertext documents, images, sounds and video. A search engine is a powerful decision-aiding tool associated with this type of DSS (Kopackova & Skrobackova, 2005).

2.3.5 Communication-driven DSS

Communication driven DSS includes communication, collaboration and coordination and GDSS focus on supporting groups of decision-makers to analyze problem situations and performing group decision-making tasks. For example, chats and instant messaging software, online collaboration and net-meeting systems (Tunban, Aronson, Liang & Sharda, 2007).

2.3.6 Web-based DSS

A Web-based decision support system is a computerized system that delivers decision support information or decision support tools to a manager or business analyst using a thin-client Web browser like Netscape Navigator or Internet

Explorer. The computer server that is hosting the DSS application is linked to the user's computer by a network with the TCP/IP protocol. To build the web-based DSS, the programmer must use multi-software such as JSP and MYSQL (Tunban, Aronson, Liang & Sharda, 2007).

2.4 Preference Queries Background

Providing personalized e-services is gradually becoming a norm in today's highly competitive environment. Many companies are starting to provide personalized Business-To-Consumer (B2C) and Business-To-Business (B2B) e-services to build a closer tie with their customers and retain their loyalty. The popularity of personalized e-services can be largely attributed to the unpleasant experience encountered by users when looking for information in the World Wide Web (Kwang, 2005).

Take e-procurement as an example. Electronic catalogues of large sites frequently offer millions of products for sale, which necessitates the assistance of a search engine. However, many of these search engines are back-ended by relational database systems that are only capable of selecting products that exactly match the users' search conditions. This frequently leads to the 'no match' effect where the query comes up empty. Subsequently, users are forced to try new queries, with possibly weaker criteria such as using 'or'-conditions. However, now they get the other extreme effect, where the query comes up with too many results, most of which are irrelevant to them. Such a search process is long and arduous and is a primary cause of users' frustration (Kiebling, 2002).

Most of the applications that exhibit such effects are typically decision support applications characterized by the following features:

1. User queries are typically based on multiple, possibly conflicting, criteria. For example, a house hunter may be interested in cheap houses near the beach. Clearly, houses near the beach are expected to be more expensive.

2. Unlike conventional applications, there may be no single optimal answer (or answer set). For our house hunter, it is unlikely that there exists a house that is both cheap and near to the beach. Instead, one can expect to find houses nearer to the beach to be more expensive.

3. Because of the second point, users are typically looking for satisfying answers that best match their criteria.

4. Even for the same query, different users, dictated by their personal preferences, may find different answers appealing. For example, our house hunter may be willing to pay more to be nearer to the beach. As such, it is important that all the best alternatives are presented to the users (Kiebling, et al, 2001).

From the above features, we can see that relational databases are not suited for supporting such applications. A relational query selects only results that exactly match the user's criteria, or it selects nothing. To support such applications, database systems have to be enhanced to support best match searches, personalized to individual's desires and tastes. Users should be allowed to pose personalized database queries, i.e., preference queries, which embed their personal preferences (Kiebling & Kostler, 1994).

The database system would then attempt to find the perfect matches from the database and should there be none, all the best alternatives are automatically retrieved. Such an approach effectively combats the ‘no match’ and ‘flooding’ effects, creating an enhanced browsing experience for the users (Kwang, 2005).

2.4.1 Supporting Preference Queries in Database Systems

The need to integrate preferences with database technology has not gone unnoticed by the database community. This has recently led to a widespread interest in enhancing the query capabilities of relational database systems to support preference queries. While the semantics of evaluating a standard, concrete database query is well defined, i.e., extract all results that match the conditions exactly, the semantics of evaluating a preference query is still open to interpretations. These are a few definitions of what we mean by dominance:

Definition: (Dominance). Given a set of user specified preferences P in query Q , we say a point x dominates another point y if all attribute values of x are as good as y_s and at least one of them is strictly better than y_s with respect to P .

Definition: (Preference Query Problem). Given a relation $R (A_1, \dots, A_d)$ containing $|R|$ data points, a preference query Q selects a subset S of points from R that are not dominated by any other points in the same relation. Points in S are commonly referred to as the maximal points of R with respect to query Q (Kontaki, et al, 2010).

The reason behind retrieving non-dominated points as the result of a preference query is due to an important property of these points. Given a set of maximal

points S , for any monotone scoring function R ! R , if $p \in R$ maximizes that scoring function, then $p \in S$. In simpler terms, no matter how the user emphasizes his/her preferences, he/she can always find his/her favorites in S (Kontaki, et al, 2010).

Intuitively, the set of maximal points, S , represents the set of satisfying answers that we describe in the previous subsection. They form the best alternatives to a user's preference query because no matter what their preferences are and how these preferences are emphasized, an appealing answer can always be found in S .

Therefore, enhancing database systems with the capability to retrieve maximal points that are based on user preferences provides a means in which preference queries can be supported in these systems (Chomicki, 2002).

The preference query problem is not something new. It is analogous to the multi-objective optimization problem well-known in operations research. In fact, it is really the maximum vector problem placed in a database context. The maximum vector problem is originally proposed in that it involves finding all maxima of a set of points. Although the maximum vector problem has been studied earlier, solving it in the database context as the preference query problem introduces new challenges.

First, the preference queries have to be evaluated over a large (although finite) dataset with limited main memory.

Second, as most applications supporting preference queries are interactive in nature, it is important that first answers are returned as quickly as possible.

Finally, if a preference query results in a large answer set, the user is unlikely to examine all the results.

To conserve valuable computational resources, partial results should be returned to users initially and more results computed upon users' request. This allows users to terminate the processing prematurely as soon as they are satisfied with the partial answers, saving precious resources in computation. In other words, answers should be returned progressively. This is particularly important in high-traffic web sites or mobile environments where resources are even more constrained. The above challenges clearly signal the need for new ways of approaching the maximum vector problem in the database context (Kwang, 2005).

2.4.2 Techniques of Preference Queries

There are several techniques used in preference queries as are discussed in the following sections.

2.4.2.1 Skyline Query

Skyline queries can be implemented on top of relational database systems, without changing the database system at all; it will become clear as we use it in this study that Skyline can be an extension to SQL. In a skyline query, users specify their preferences in terms of whether they favor low, high or different values of the attributes (Borzsonyi , Kossmann & Stocker, 2001). All specified preferences are also regarded as equally important. It is based on the dominance relationship between tuples. Assuming that smaller values are preferable in all dimensions, the dominance relationship and the skyline are defined as follows:

Definition: (dominant tuple). A tuple t_i dominates another tuple t_j ($t_i < t_j$), if and only if t_i is smaller than or equal to t_j in all dimensions and it is strictly smaller than t_j in at least one of them.

Definition: (skyline). The skyline consists of the tuples not dominated by any other tuple (Chomicki, 2002).

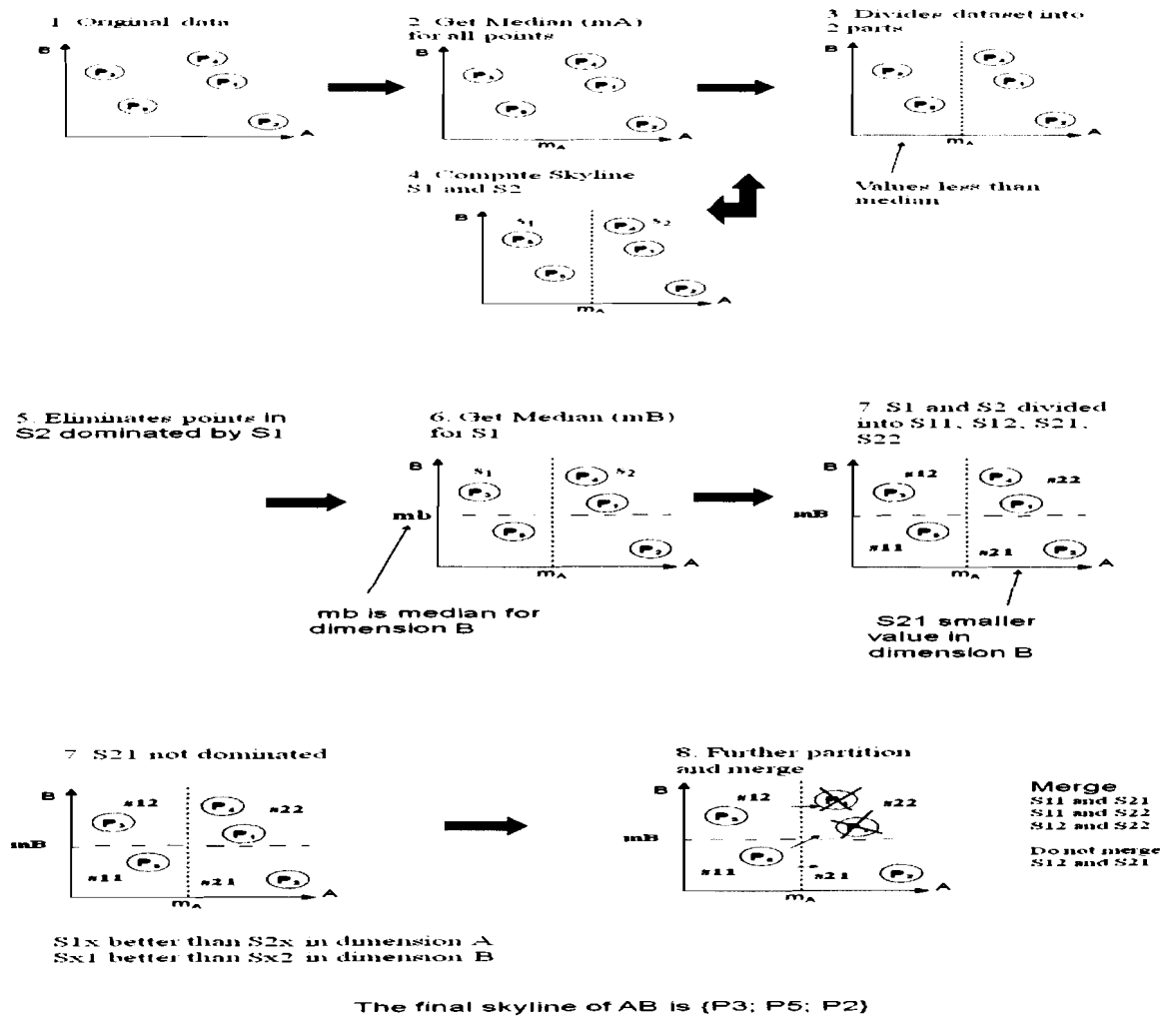


Figure 2.1: Skyline Algorithm (Borzsonyi, Kossmann & Stocker, 2001)

The key advantage of the skyline query is that it does not require any user-defined information or parameter. Moreover, skyline queries are characterized by the scaling invariance property, which means that if scaling is applied to any dimension values, the result remains unchanged. On the other hand, as the dimensionality increases, the probability for a tuple to dominate another tuple is reduced significantly and, therefore, the number of skyline tuples increases substantially. Overall, the skyline query does not bound the size of the output and, therefore, in extreme cases it is possible that all the tuples are a part of the skyline result (C.Y. Chan et al, 2006).

2.4.2.1.1 Translating a Skyline Query into a Nested SQL Query

Skyline queries can be implemented on top of a relational database system by translating the Skyline query into a nested SQL query and a demonstration of this in the following example of SQL code (Borzsonyi, Kossmann & Stocker, 2001):

```
SELECT *
FROM Table T
WHERE T. Column1 = '' AND NOT EXISTS(
SELECT *
FROM Table T1
WHERE T1. Column1 = '' AND T1.Column2 <= T. Column2 AND
T1.Column3 <= T.Column3 AND
(T1.Column2 <= T. Column2 OR T1.Column3 <= T.Column3));
```

2.4.2.2 *Top-k Queries*

A top-k query uses a user-defined preference function to assign scores to tuples and rank them. Assuming that smaller values of the preference function are preferable, the top-k query is defined as follows:

Definition: (top-k). Given a data set and a preference function F , a top-k query returns the k tuples in the data set with the smallest scores according to F (Chomicki, 2002).

In contrast to skyline queries, top-k queries bound the output size. If two or more tuples have the same score, then we can either:

- (a) Report all these tuples, but we may expect more than k tuples in the result.
- (b) Use a tie-breaking criterion, e.g., the value of a specific dimension (Chomicki et al, 2003).

The major disadvantage of the top-k query is that it requires a user-defined preference function. This means that different preference functions can lead to different score assignments and therefore in different results. Thus, the analysis of the results is not straightforward. Moreover, it is not always easy for a user to specify the appropriate preference function, especially with a growing number of dimensions. Due to that in this research we use skyline query techniques (Chomicki, 2002).

2.5 Base preferences (Criteria)

A Base preference or criteria is a partial order \preceq_V based on a set V of values of one particular data type. In this research we used data types String, Boolean and Number. Base preference themselves are either explicitly definable by the user or they can be pre-defined (Kiebling, et al, 2001).

2.5.1 User-Definable Explicit Preference

Let's assume a customer named Julia wants to buy compact discs at an e-shop. Her decision depends (among other things) on her personal preferences among music categories of the CD's available. Her preference is expressed as explicitly listed partial order as shown in figure 1 (an arrow representing a better-worse relationship). Thus Julia prefers classic and opera music most. If this perfect choice is not available, she prefers jazz or blues next. Comedy and rock are appropriate if none of the mentioned categories are available. In the worst case none of the preferred categories are available. Only then other CD's would qualify (Kiebling, et al, 2001).

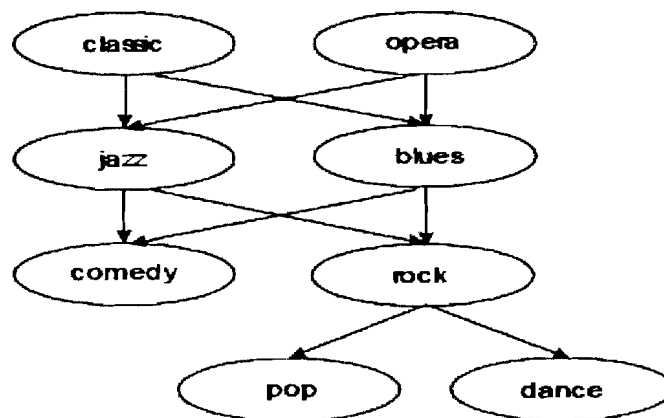


Figure 2.2: Base preference as a user-definable explicit partial order (Kiebling, et al, 2001).

2.5.2 Predefined Base Preferences

Explicit preferences are a powerful means to specify preferences in finite domains. However, in many situations this can become very tedious. Therefore a set of predefined base preferences will be supplied, all of which can be described by partial orders. From the experiences gained with Preference Query Technique in typical e-commerce domains like Internet portals for flight booking, car sales, real estate brokerage and many more, the subsequent choice was found as very appropriate (Kiebling, et al, 2001).

- **“Around” Preference**

Suppose Julia wants to buy a car, the price should be around \$10.000. It is unlikely that she finds an exact match, but there may be a lot of cars that come very close to this value. The “around” preference is used if an exact value is not a must, alternatively closest matches are acceptable. Values closer to the exact match are better than others (Kiebling, et al, 2001).

- **“Interval” Preference**

Julia wants to buy a book within a price range of \$10 up to \$20. An “interval” preference rates all such books as equally good, books outside this range are considered worse. Analogously to the "around" preference, books outside but very close to the interval borders are better than those farther away. As special cases, one-sided intervals are supported (i.e., one interval boundary may be unspecified) (Kiebling, et al, 2001).

- **“Extremal” Preference**

Michael wants to buy a book, preferring the cheapest one. In terms of our preference model this means minimizing the price attribute. “Extremal” preferences are used to minimize or maximize an attribute. Values closer to the extremal value are preferable to those farther away (Kiebling, et al, 2001).

- **“Positive” Preference**

This time Julia wants to buy a car, preferring the colors red and blue. If cars with either of these colors are in stock, they will be offered to Julia. Otherwise cars with different colors are an alternative choice. This type of preference is called “positive” preference. Any value in the positive set is rated better than the rest (Kiebling, et al, 2001).

- **“Negative” Preference**

“Negative” preferences behave opposite to “positive” preferences. Each value not contained in the negative set is preferred. If Julia wanted to buy a car and disliked the colors magenta and cyan, cars with a different color are preferable. Additionally we support so-called “pos/neg” preferences and “pos/pos” preferences, combining the properties of “positive” and “negative” preferences (Kiebling, et al, 2001).

2.5.3 Combination of Preferences

In practice preferences and purchase decisions are rarely 1-dimensional, but much more complex in general. To construct more complex preferences, base preferences can be combined by two principal methods: prioritization and cumulation (Chomicki, 2002).

2.5.3.1 Accumulation of Preferences

Accumulation treats several preferences on different attributes as equally important: Object x is better than object y , if x is better than y according to at least one preference and at least equally good with respect to the other preferences (Davey & Priestley, 1990).

This corresponds to the well-known Pareto optimality principle, which has been applied and studied extensively in particular for multi-attribute decision problems (Davey & Priestley, 1990).

Assume that Jutta is looking for a car. Ideally, it should display the following equally important characteristics: to be one year old, to be a BMW and to be a roadster. Thus Jutta's preference translates into a accumulation of three proper base preferences. The Pareto principle guarantees that exactly the set of best matching cars is found. Obviously, an existing perfect match (a one year old BMW roadster) would dominate all other cars. If not available best alternatives would be searched for Jutta automatically. Thus the Pareto-optimality semantics for multi-attribute preferences avoids the often occurring and embarrassing "empty-result"

effect of many Internet search engines, if no exact matches are available. Moreover, it also avoids the annoying flooding effect with a lot of irrelevant results, because worse objects (i.e. object that are subsumed by better ones) are filtered out on the fly (Kiebling, et al, 2001).

2.5.3.2 Prioritization of Preferences

Prioritization treats preference p_1 as more important than preference p_2 , which in turn is more important than p_3 , etc. , up to preference p_n :

- Object x is better than object y , if x is better than y according to p_1 .
- If x and y are equally good according to p_1 , then p_2 will decide which one is better, etc.

Therefore accumulation and prioritization are construction operators for complex preferences that can even be applied orthogonally (Davey & Priestley, 1990).

By example let's assume that Michael searches for a book. For him the most important attributes are author and title. Less important he wants to spend as little money as possible. Prioritization can be used to express this situation by cumulating the author and title preferences as most important preference p_1 , followed by an "extremal" preference p_2 (Davey & Priestley, 1990).

2.6 Malaysian Public Universities

Recent years a global consensus has emerged in the importance of investing in human capital, which is viewed as an essential part of efforts to raise incomes and achieve sustained economic growth for a country. In that respect, the human capital produced from the university educational system should be competitive in terms of knowledge and skills and in terms of character and integrity. The Malaysian government regards highly-skilled human capital as the nucleus of a knowledge-based economy and has been attempting to reform higher-educational policies in both the public and private sectors since the 1990s (Padlee & Kamaruddin, 2010).

Public universities are run by the Government with objectives in line with the Ministry of Higher Education (MOHE). The main objectives of MOHE are to produce human capital with a first-class mentality, dynamic, competitive, and able to face the challenges of a changing world (MOHE, 2010).

2.6.1 List of Public Universities in Malaysia

The 20 public universities of the Malaysian Government are grouped into 3 categories: 4 Research universities, 4 Comprehensive universities and 12 Focused universities (see Figure 2.1) (MOHE, 2010).

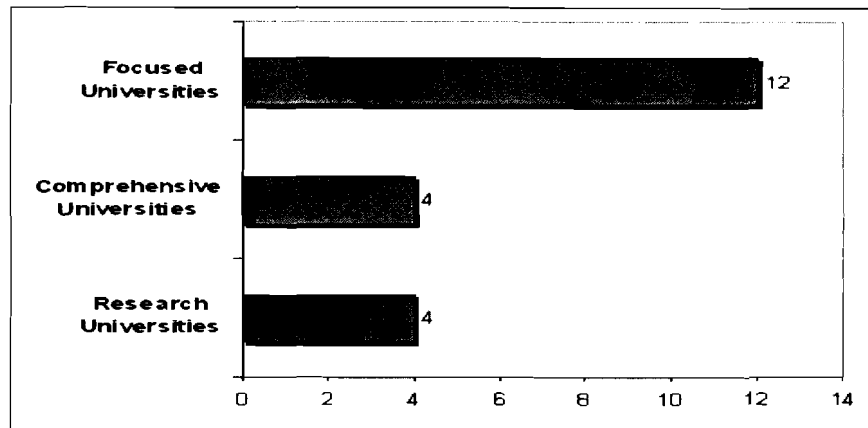


Figure 2.3: Three Categories of Public Universities in Malaysia

➤ **University of Malaya**

The University of Malaya (Abbreviation: UM; Malay: *Universiti Malaya*) is located on a 992-acre campus near the centre of Kuala Lumpur, and is the oldest university in Malaysia. It was founded in 1905 as a public-funded tertiary institution. Today, UM is an acclaimed Research University, with 2,613 academic staff with a variety of expertise and 590 supporting staff (UM).

The THES - QS World University Rankings (From 2010 two separate rankings will be produced by the Times Higher Education World University Rankings and the QS World University Rankings) has ranked UM in the top 200 universities of the world, although its position has varied from 89 to 246. It was ranked 89, 169, 192, 246, 230, 180 and 207 for the years 2004 to 2010 respectively, and these fluctuations were perceived as a progressive drop and became an object of public questioning and controversy about the perceived declining standards of Malaysian

universities and the apparent lackadaisical attitude of UM in addressing long standing issues. This prompted the Ministry of Higher Education to establish its own competitive ranking system between Malaysian public universities known as the Rating System for Malaysian Higher Education Institutions or SETARA following an Academic Reputation Survey conducted the year before (UM).

➤ **University of Technology Malaysia**

Universiti Teknologi Malaysia (University of Technology Malaysia) is the oldest public engineering and technological university in Malaysia and is known by the abbreviation UTM. The university specializes in technical studies, with separate faculties for Education, Pure Sciences ,Management, and Human Resources Development. It is the country's major source of graduate engineers and similar professionals. Alumni of UTM have been instrumental in developing sectors related to engineering and technology in Malaysia. Of its more than 20,000 students, over 25% are postgraduates. Since the 1990s, the number of foreign students, particularly from neighboring Asian countries, the Middle East, and Africa, has been increasing, especially in postgraduate programs. UTM graduates have gone on to many academic and professional institutions across the world (UTM).

➤ **University Utara Malaysia**

Universiti Utara Malaysia (English: *Northern University of Malaysia*) (UUM) is a public university in the town of Sintok, Kedah. *Utara* means 'northern' in

the Malay language. It was formally incorporated on 16 February 1984.

The university was established with the specific mission of providing a leadership role for management education in the country. Thus, the university is also known as a management university. The academic establishments in UUM include College of Business (UUM COB), College of Law, Government and International Studies (UUM COLGIS) and College of Arts and Sciences (UUM CAS). UUM is the first university in the country to be a fully wired using fiber-optic cables. The university has 29 computer laboratories in academic and administrative buildings on the campus, providing students with access points for e-services (UUM).

➤ **University Malaysia Kelantan**

Universiti Malaysia Kelantan (English: University of Malaysia, Kelantan) or UMK is a public university located in Kelantan in Malaysia. The formation of the university was mooted during the tabling of the Ninth Malaysia Plan and subsequently approved by the cabinet of Malaysia on June 14, 2006. The first students were enrolled with the commencement of the June 2007 semester (UMK).

Currently UMK operates from their temporary campuses in Pengkalan Chepa and Kota Bahru. A permanent campus is being planned in the towns of Bachok and Jeli (UMK).

➤ **University Tun Hussein Onn Malaysia**

Universiti Tun Hussein Onn Malaysia (Abbreviation:UTHM) (English: Tun Hussein Onn University of Malaysia) is a public university in Batu Pahat, Johor, Malaysia. It was formerly known as Institut Teknologi Tun Hussein Onn (ITTHO) and Kolej Universiti Teknologi Tun Hussein Onn (KUiTTHO). Along with other public university colleges, KUiTTHO was promoted to full university status. The name, UTHM was officially launched by the then education minister, Dato' Seri Hishammuddin Bin Tun Hussein (UTHM).

➤ **University Pertahanan Nasional**

Universiti Pertahanan Nasional (UPNM) or the National Defense University of Malaysia is a military university located in Sungei Besi Camp, Kuala Lumpur. The university is Malaysia's first catering to the needs and development of modern armed forces. As of year 2008, it has around 1,500 undergraduate students; with over 1,300 of them are Officer Cadets (UPNM).

➤ **Technical University of Malaysia Malacca**

Universiti Teknikal Malaysia Melaka (UTeM) or Technical University of Malaysia Malacca is a public university located in Durian Tunggal, Melaka, Malaysia. It is the pioneer in the use of the "Practice and Application Oriented" teaching and learning method for tertiary level technical education in Malaysia (UTeM).

➤ **Islamic Science University of Malaysia**

Universiti Sains Islam Malaysia (English: Islamic Science University of Malaysia) or USIM is a public university in Malaysia with a main campus located at Nilai, Negeri Sembilan. Formerly known as Kolej Universiti Islam Malaysia (English : Islamic University College of Malaysia) or KUIM which was established in 1998, USIM presently has 8 faculties with 18 academic programs with academic programs that encompasses all branches of knowledge such as economy, law, syariah, language, da'wah, management, Quran and Sunnah, Fiqh, counseling, communication, medicine, science & information technology, dentistry and accounting (USIM).

➤ **University Malaysia Pahang**

Universiti Malaysia Pahang (English: University of Malaysia, Pahang) (UMP) is a Malaysian government university. It was formerly known as Kolej Universiti Kejuruteraan dan Teknologi Malaysia (English: University College of Engineering & Technology Malaysia) (KUKTEM). UMP was established as a public technical university by the Malaysian government on 16 February 2002. Incorporated under the Universities and University Colleges Act 1971 by the Royal Decree of His Majesty the Yang DiPertuan Agong, Kolej Universiti Kejuruteraan & Teknologi Malaysia (KUKTEM) was set up as a competency-based technical university, specializing in engineering and technology. The University College of Engineering & Technology Malaysia currently operates on a temporary campus in Gambang, Pahang. The temporary campus was formerly an industrial complex owned by

MEC. The university's permanent campus is located in Pekan, which is currently still under construction (UMP).

➤ **University Science Malaysia**

Universiti Sains Malaysia (acronym: USM) is a public university with its main campus in Penang, Malaysia. There are three branch campuses: one in mainland Penang (Engineering), one in Kelantan on the east coast of Peninsular Malaysia, and a offshore collaboration with a university in India. This offshore five-year M.D. program is conducted at the Jawaharlal Nehru Medical College (Belgaum), KLE University, Belgaum, Bangalore, India offering the MD (USM) or better known as the Doctor of Medicine undergraduate degree. USM plans to open a Kuala Lumpur campus. With around 28,287 (postgraduates and undergraduates) students in 2009, USM is one of the biggest universities in terms of enrollment in Malaysia (USM).

➤ **University Pendidikan Sultan Idris**

Universiti Pendidikan Sultan Idris (English: Sultan Idris University of Education) or UPSI is a public university in the town of Tanjung Malim, Perak in Malaysia. First established in 1922 as a teachers college, it is one of the oldest functioning institutions of higher learning in Malaysia (UPSI).

➤ **University Malaysia Perlis**

Universiti Malaysia Perlis (English: University of Malaysia, Perlis) or UniMAP is located at the northernmost part of the Malaysian peninsula, less than 35 km from the Thailand border in the town of Arau, Perlis (UniMAP).

➤ **University Malaysia Sabah**

Universiti Malaysia Sabah (English: Sabah University of Malaysia) or UMS is the ninth Malaysian public university located in Kota Kinabalu, Sabah, Malaysia and was established on November 24, 1994. His Majesty the Yang di-Pertuan Agong proclaimed the establishment of UMS under Section 6(1) of the Universities and University Colleges Act 1971(UMS).

➤ **University Malaysia Sarawak**

Universiti Malaysia Sarawak (English: University of Malaysia, Sarawak) or UNIMAS was officially incorporated on 24 December 1992. UNIMAS is Malaysia's eighth University, established just after the declaration of Vision 2020 (UNIMAS).

The University took in its first students numbering 118 in 1993 with the opening of the Faculty of Social Sciences and Faculty of Resource Science and Technology. These students were temporarily located at Kolej Latihan Telekom, Simpang Tiga, Kuching until in 1994 the University moved to its East Campus in Kota Samarahan, Sarawak. The University's East Campus at Kota Samarahan was

officially launched by the Prime Minister, YAB Dato'Seri Dr. Mahathir Mohamad on Independence Day, 31 August 1993 (UNIMAS).

➤ **The International Islamic University Malaysia**

The International Islamic University Malaysia (Arabic: الجامعة الإسلامية العالمية ماليزيا), also known as IIUM or UIAM, is a public publicly-funded university in Malaysia. Its main campus is located in Gombak, Selangor with its Centre for Foundation Studies situated in Petaling Jaya , Nilai and its medical-centric branch in Kuantan, Pahang. The university is sponsored by eight different governments from the Organization of the Islamic Conference (OIC). It is completely distinct from the International Islamic University Islamabad, Pakistan and International Islamic University in Chittagong, Bangladesh (IIUM).

The University was established in 23 May 1983, founded on Islamic principles with the aim to become the premier Islamic university in the world. It was meant to be a comprehensive international high education institution, "inspired by the world-view of Tawhid and the Islamic philosophy of the unity of knowledge as well as its concept of holistic education". Islamic values are inculcated into all disciplines. At present, the University offers various bachelor, master's degree and PhD courses at its 13 faculties, also known as kuliyyah(IIUM).

➤ **The National University of Malaysia**

The National University of Malaysia (Malay: Universiti Kebangsaan Malaysia) is a public university located in Bangi, Selangor which is about 35 km south of Kuala Lumpur. Its teaching hospital, Universiti Kebangsaan Malaysia Medical Centre (UKMMC) Pusat Perubatan Universiti Kebangsaan Malaysia (PPUKM) is located in Cheras[disambiguation needed] and also has a branch campus in Kuala Lumpur. Currently there are 17,500 undergraduate students enrolled, and 5,105 postgraduate students of which 1368 are foreign students from 35 different countries. Universiti Kebangsaan Malaysia is one of the five research universities in the country. It was ranked by The Times Higher Education Supplement (THES) at number 185 in its annual ranking of the world's top 200 universities for 2006 (UKM).

➤ **MARA University of Technology**

Universiti Teknologi MARA (Abbreviation: UiTM English: MARA University of Technology) is a Malaysian public university. The main objective of this institution is to provide professional programs of study in fields including engineering, law, science, medicine, technology, business, arts and humanities as well as being a research university (UiTM).

➤ **University Putra Malaysia**

Universiti Putra Malaysia (English: Putra University, Malaysia), or UPM, is a leading research intensive public university located in central Peninsular Malaysia, close to the capital city, Kuala Lumpur. It was formerly known as Universiti

Pertanian Malaysia or Agricultural University of Malaysia (Malay: universiti, university; pertanian, agriculture; Malaysia). UPM is a research university offering undergraduate and postgraduate courses with a research focus on agricultural sciences and its related fields. Ranked joint 319th best university in the world in 2010 by Quacquarelli Symonds, UPM is taking steps to boost its research capabilities both in and beyond the scope of agriculture (UPM).

➤ **University Malaysia Terengganu**

The Universiti Malaysia Terengganu (English: University of Malaysia, Terengganu) or UMT, formerly known as Kolej Universiti Sains dan Teknologi Malaysia (English: University College of Science and Technology Malaysia) (UMT).

2.7 Summary

In the above sections, we have explained the definition and types of DSS. In a brief discussion we discussed the various types of preference query techniques. Moreover, we describe the reasons why we chose preference queries and how it features in E-commerce, also we talk about public universities in Malaysia In the next chapter we will discuss the research methodology in this project.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Methodology

Research methodology is a systematic way to solve research problems (Kothari, 2005). The research method refers to the method and techniques used by the researcher in performing the research. This chapter discusses the methodology used in this project to achieve the project objectives.

In this project, the methodology that was used for developing the web-based decision support system is the rapid application development (RAD) method. Rapid application development is a software development methodology that involves using methods like iterative development and software prototyping. According to Kothari (2005), it is a merger of various structured techniques, especially data-driven Information Engineering, with prototyping techniques to accelerate software systems development.

In RAD, structured techniques and prototyping are especially used to define users' requirements and to design the final system. The development process starts with the development of preliminary data models and business process models using structured techniques. In the next stage, requirements are verified using prototyping, eventually to refine the data and process models. These stages are repeated iteratively; further development results in "a combined business

requirements and technical design statement to be used for constructing new systems" (Kopackova & Skrobackova, 2005).

3.2 Life cycle of RAD

The prototyping approach starts with DSS planning and some analysis. Next, the analysis, design, and prototype implementation phases are iteratively performed until a small prototype is sufficiently developed. Then the final implementation of this part of the DSS takes place. Simultaneously, further iteration occurs in the loop of the analysis-design-implementation-system prototype as other subsystems are added to the deployed system until a fairly stable, comprehensive system evolves (Kopackova & Skrobackova, 2005).

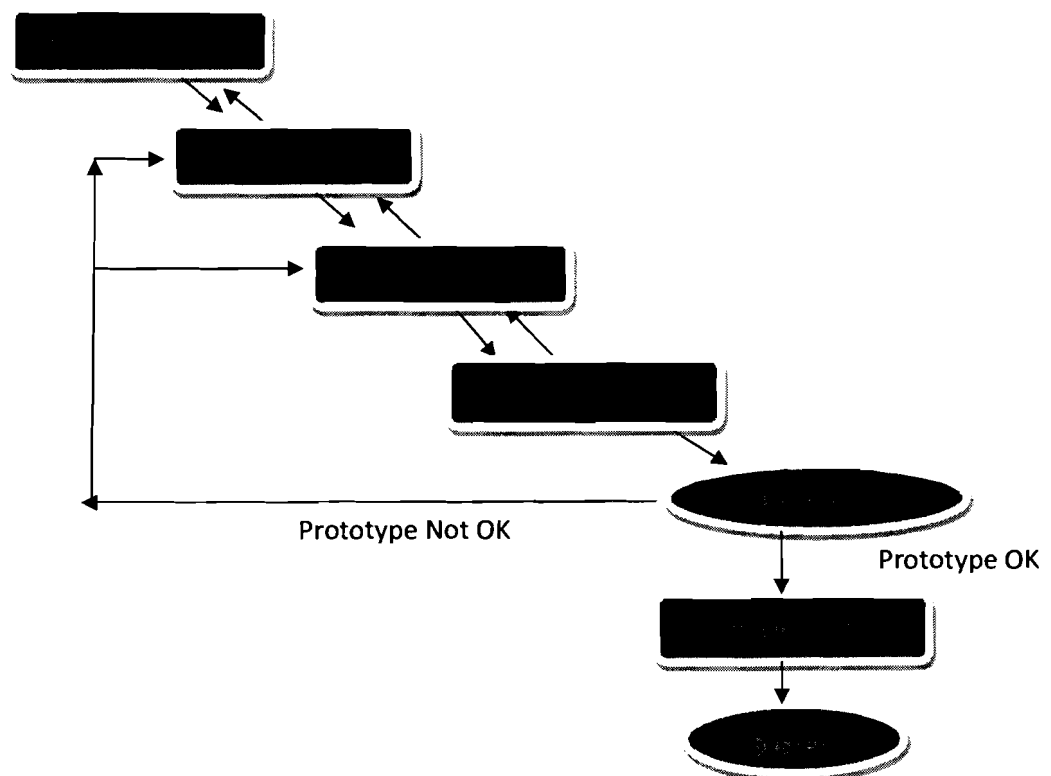


Figure 3.1: Prototyping Development Process: A RAD Method

3.2.1 Planning Stage

The first stage in this phase is to create (gather the requirements for the system) a list that could be used by the end user. Furthermore, this phase includes a detailed study of the DSS architecture. Moreover, this phase will identify the common user tasks such as how the individual programs are going to work, what are the interfaces going to look like and what data will be required (Kopackova & Skrobackova, 2005).

3.2.1.1 DSS Architecture

The DSS architecture in this research aims to help international students who they want to study in Malaysian public universities to choose the right universities based on their criteria. DSS architecture is built based on four main components, which are the data in terms of Malaysian public universities data, preference query techniques; suggested universities that are given by system and interfaces (see Figure 3.2).

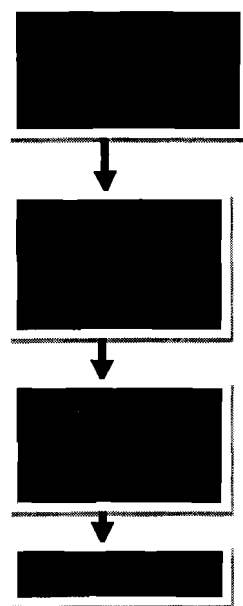


Figure 3.2: DSS Architecture for Choosing Malaysian Public Universities

3.2.1.1.1 Malaysian Public University Data Source and Collection

Data source and collection was done by observation of Ministry of Higher Education and Malaysian public universities' web sites to collect the primary data. Table 3.1 below shows the data type, data and the source for description of the data. That will be used as input for the DSS prototype later, for more information, sees Table 3.1.

Table 3.1: Data type as Input in the DSS Prototype

Type of data	Data	Source of information
Malaysian public universities	20 public universities in Malaysia Details of data field required in Universities as shown below: University ID University Name University Area Type of Accommodation	Observation of MOHE & Malaysian public universities web sites
List & details of courses	Details data field require in courses as shown below: Course ID Course Name Course Type(PhD, Master, Undergraduate) Course Mode((Full time, Part time) Course Fee Course Duration Language	Observation of Malaysian public universities web sites

3.2.1.1.2 Preference Query Techniques (Model)

The model in this project is the preference query technique (skyline), which processes the international student criteria and comes out with suggested universities.

3.2.1.1.3 Suggested Universities (Knowledge)

Suggested universities come out in order based on international students who enter his/her criteria.

3.2.1.1.4 Interfaces

The web-based interfaces were designed using JSP and contain links with universities' official web sites. The main website interface contains Malaysian public university information and through this page the user can enter the search engine page, which contains criteria that should be entered by international students. The result page contains the suggested universities with links to each official web site.

3.2.2 Analysis Stage

The aims of this phase are to analyze the problems by determining three important things, which are input, processing and output of the DSS. The requirements-gathering process takes as its input the goals identified in the high-level requirements section of the project plan. Each goal will be refined into a set of one or more requirements (Kopackova & Skrobakova, 2005).

3.2.3 Design Stage

The design stage takes as its initial input the requirements identified in the approved requirements document. For each requirement, a set of one or more design elements will be produced as a result of prototype efforts (Kopackova & Skrobackova, 2005).

Design elements describe the desired software features in detail, and generally include use case diagrams, activity diagrams, sequence diagrams and class diagrams. These design elements are conducted by using Unified Modeling Language (UML).

3.2.3.1 Unified Modeling Language

Unified Modeling Language (UML) is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed by, and was created by, the Object Management Group. UML includes a set of graphic notation techniques to create visual models of object-oriented software intensive systems.

The UML standard defines many types of diagrams:

- Use Case: models the functionality of a system in terms of user interaction
- Activity: models the flow of a system from action to response
- Sequence: describes the interaction between classes in terms of message exchanges
- Class: defines the structure of a system

3.2.4 Implementation Stage

The implementation stage takes as its primary input the design elements described in the approved design document. For each design element, a set of one or more software artifacts will be produced. Appropriate test cases will be developed for each set of functionally related software artifacts.

The outputs of the implementation stage include a software prototype that satisfies the requirements and design elements previously documented, an implementation that identifies the primary code entry points for all major DSS prototype functions, and a test plan that describes the test cases to be used to validate the correctness and completeness of the DSS prototype (Kopackova & Skrobakova, 2005).

3.3 Summary

This chapter describes the RAD method that was used to solve the research problem and achieve the aim of this study. Moreover, the chapter also explains the DSS architecture and its components.

CHAPTER FOUR

ANALYSIS, DESIGN AND IMPLEMENTATION

4.1 Introduction

In this chapter, we analyze, design and develop the Web-based DSS prototype for choosing Malaysian public universities by using preference query techniques, which was discussed in the previous chapter. The result of the preference queries model as a Web-based DSS was developed to solve the issue of choosing wrong universities that can made by international students, in order to give them a chance to choose universities based on their criteria that can make them continue their studies easily. Relevant information, requirements, analysis and design needed to develop the Web-based DSS are presented in the early sections of this chapter. The findings (implementation & testing) are presented in the last sections of this chapter.

4.2 Designing Web-based DSS

Designing a Web-based DSS includes four stages, which are, DSS determines user requirements, DSS analysis and design, DSS implementation and DSS maintenance and testing.

4.2.1 DSS Determines User Requirements

In the determining user requirements phase we are going to list down the functional requirements and non-functional requirements of DSS for choosing

Malaysian public universities by using preference queries. The functional requirement defines a function of a software system or its component (A function is described as a set of inputs, the behavior, and outputs), whereas non-functional requirements are a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviours such as security, usability, testability, maintainability, extensibility and scalability, which are used to execute and evaluate the software system. Table 4.1 and 4.2 below show the functional and non-functional requirements for choosing Malaysian public universities.

Table 4.1: Functional requirements

No.	Requirement ID	Requirement Description	Priority
	MPU-Search Engine_01	View Universities information	
1.	MPU-Search Engine _01_01	The system allows the students to view the information of the website.	M
	MPU-Search Engine _02	Search for suitable university	
2.	MPU-Search Engine _02_01	The student can search for the suitable university to enroll by entering their own criteria in the system.	D
	MPU-Search Engine _03	Log-in	
3.	MPU-Search Engine _03_01	The Administrator can log-in into the system by using his/her “user name” and “password”	M
4.	MPU-Search Engine _03_02	The system shall detect the validation of “user name” and “password”	D

	MPU-Search Engine _04	Manage Universities information	
5.	MPU-Search Engine _04_01	The Administrator can create new universities information.	M
6.	MPU-Search Engine _04_02	The Administrator can update & delete existing university information.	M
	MPU-Search Engine _05	Search for specific courses information	
7.	MPU-Search Engine _05_01	The system allows students to search & query for university information based on their criteria.	D
	MPU-Search Engine _06	Log-out	
8.	MPU-Search Engine _06_01	The Administrator makes the log out of the system.	M

Table 4.2: Non-functional requirements

No.	Requirement ID	Requirement Description	Priority
	MPU-Search Engine _07	Usability issues	
9.	MPU-Search Engine _07_01	<ul style="list-style-type: none"> - The system must provide easy access. - The system must have a friendly interface. 	M
	MPU-Search Engine _08	Operational requirements	
10.	MPU-Search Engine _08_01	<ul style="list-style-type: none"> - The system will have a server for the database and a connection to the main database. - The system will work over the web environment with Internet Explorer. 	M

	MPU-Search Engine _09	Performance requirements	
11.	MPU-Search Engine _09_01	<ul style="list-style-type: none"> - The system database must be updated in real time. - The system should be available 24/7. 	M
	MPU-Search Engine _10	Security requirements	
12.	MPU-Search Engine _10_01	Only the Administrator should have user name and password to access the system.	M

In Tables 4.2 and 4.3, the priority column, the following abbreviations are used in the tables above, and explained as follows: M refers to mandatory requirements, D refers to desirable requirements and O refers to optional requirements.

4.2.2 DSS Analysis and Design

The system analysis phase takes over where the requirements analysis stopped. The system analysis focuses on the internal architecture of the system. The system analysis is finished when there is a consistent and well-understood definition of the major objects needed in the system, including a clear definition of the responsibilities for the different objects, and the architecture is validated using the analysis use cases. The System Design phase takes the System Specification and designs the architecture of the system. It is done by defining a series of components with what they can do and how they interact with other components. These components can be other systems, interfaces, modules of code, screens and

databases. In the Design Phase for this study we will use the UML Activity Diagram, Sequence Diagram and Class Diagram.

4.2.2.1 Use Case Diagram

Use case diagrams describe what a system does from the standpoint of an external observer. The emphasis is on what a system does rather than how. Use case diagrams are closely connected to scenarios. A scenario is an example of what happens when someone interacts with the system. A use case is a summary of scenarios for a single task or goal. An actor is who or what initiates the events involved in that task. Actors are simply roles that people or objects play.

Use case diagrams are helpful in three areas.

- **Determining features (requirements).** New use cases often generate new requirements as the system is analyzed and the design takes shape.
- **Communicating with clients.** Their notational simplicity makes use case diagrams a good way for developers to communicate with clients.
- **Generating test cases.** The collection of scenarios for a use case may suggest a suite of test cases for those scenarios.

In this study case we have two main 'Actors', which are the Administrator, and Student (refers to international students who want to enroll in Malaysian public universities), the main functionalities of the Administrator are management of the web site (create new accounts and new university information, create or update records). About the students, the main functionalities are viewing info, and the search for suitable universities based on their criteria.

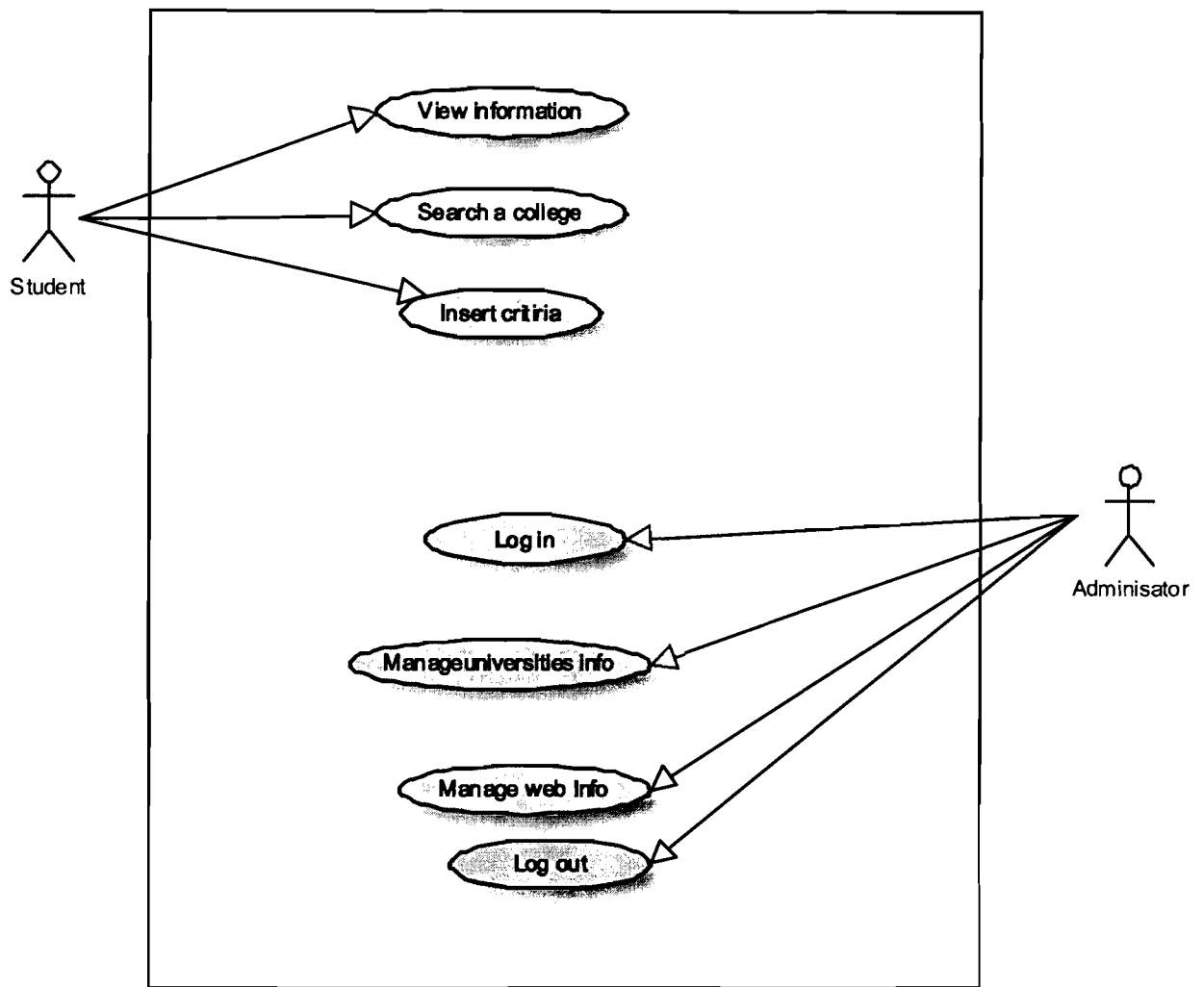


Figure 4.1: Use Case Diagram

4.2.2.1.1 Use Case Specifications

The use case specification gives a specific description for each use case and focuses on describing how to achieve a goal or a task.

➤ Use Case: View Information

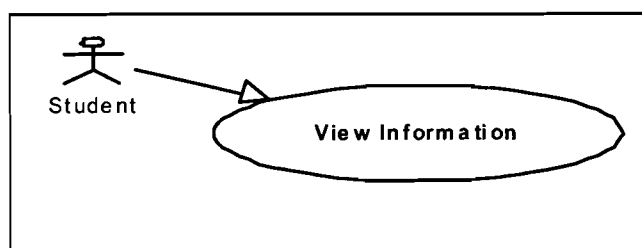


Figure 4.2: Use Case View Information

- **Brief description**

This use case is initiated by the Student. This use case will enable the Student to view Malaysian public university information.

- **Pre-condition**

The user already enters into the system as a (Student).

- **Characteristic of activation**

Event Driven (on user's demand).

- **Flow of events**

This use case begins when the user access to web site, there is a logo for each public university in Malaysia. The user can press the button for a specific public university to view college information available and other important information in that university.

- **View the University that are available**

If the Student presses on the university logo button to view the college and university facility details, the system will display all the colleges that are available.

➤ **Use Case: View university**

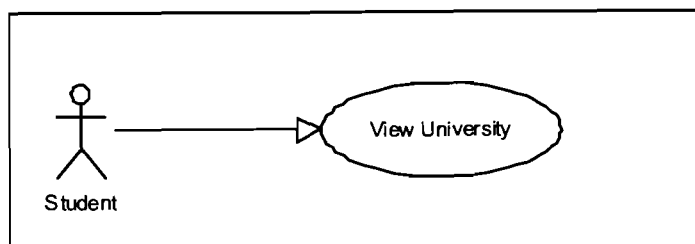


Figure 4.3: Use Case View University

- **Brief Description**

This use case is initiated by one actor Student. By using this use case, the user of the system can insert his/her search criteria.

- **Preconditions**

System ready to work.

- **Characteristics of Activation**

Event Driven (on user demand).

- **Flow of events**

This use case begins when the user presses the student insert criteria button in the web site; there are three list boxes that will appear to let the student insert his/her own criteria into the system.

➤ **Use Case: Search for Suitable College**

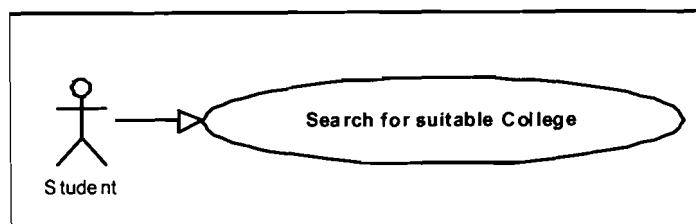


Figure 4.4: Use Case Search for Suitable University

- **Brief description**

This use case is initiated by one actor Student. This use case will enable the Student to search for suitable colleges that are available with all details according to specific criteria.

- **Pre-condition**

The user presses on search button as a Student.

- **Characteristics of activation**

Event Driven (on user's demand).

- **Flow of events**

This use case begins when the user presses the student search button in the insert criteria page in the web site; a list of universities will appear. This list is the search result

The student can press on any university name to take him/her to the university link.

➤ **Use Case: Log-in**

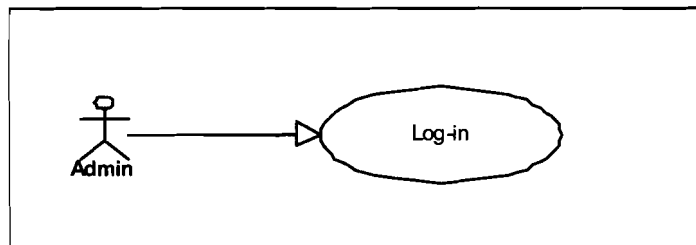


Figure 4.5: Use Case Log-in

- **Brief Description**

This use case is initiated by the user administrator. This use case will enable the user to login to the system.

- **Pre-condition**

The user must have an account, and have a user name and password.

- **Characteristics of Activation**

Event Driven (on user demand).

- **Flow of event**

This use case begins when the user presses the <<login>> button at the main page.

The system will display the login Page to allow users to input their ID and password [A1: Cancel].

After that, the user will press the "LOGIN" button to login to the system, then the system verifies the ID and password. [E-1: Invalid password/username].

The system will display the home page for the user and determine which functions are available for him/her.

- **Alternative Flow**

Cancel: If the user presses the Cancel button, the system returns to the main page.

- **Exceptional Flow**

E-1: Invalid Password/Username: The system will display an error message and the user has to re-enter the username and password.

- **Post-Condition**

The User will be able to proceed to other activities.

- **Constraint**

The user must enter the correct user name and password.

- **Use Case: Manage Universities Information**

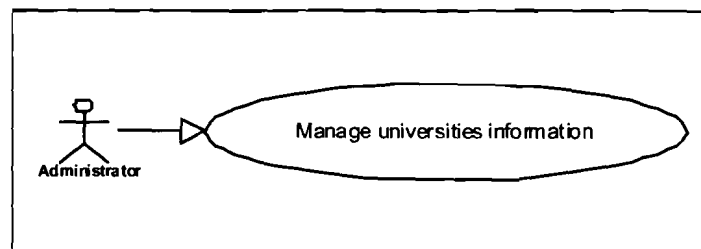


Figure 4.6: Use Case Manage Universities Information

- **Brief description**

This use case is initiated by one actor, the Administrator. This use case will enable the Administrator to manage university information by creating, updating, inserting and deleting university information records.

- **Pre-condition**

The user presses on the manage information button as a Administrator.

- **Characteristic of activation**

Event Driven (on user's demand).

▪ **Flow of Events**

This use case begins when the user presses the Manage Universities information button, then a new page will appear with three options [A-1: Create new universities record], [A-2: delete universities record], [A-3: update universities record].

▪ **Alternative Flow**

- A-1 : Create new university record : this use case is initialized by the administrator, when they press the <<create new university record>> button, the page will appear and the administrator can fill in the new university information (Id, name....) and press the <Save> button [E-1: some fields are empty] [E-2:confirm message]

- A-2 : delete university record : this use case is initialized by the administrator when they press the <delete university record> button, the delete page will appear and the user must enter the university id to delete [E-3 : wrong university id].

-The system will display Information University for the account the administrator would like to delete.

-The administrator must press the confirm button for deleting the university record [E-for: confirm message].

- A-3: update university record: this use case is initialized by the administrator when they press the <update university record> button; the update page will appear and the user must enter the university id to update [E-5: wrong university id]

-The system will display Information University for the account the administrator would like to update.

-The administrator can change the data and press the confirm button for updating the account [E-6: confirm message].

- **Exceptional Flow**

E-1: some fields are empty: Message box will appear to confirm to the administrator that some fields are empty; the administrator can return and reenter these fields.

E-2: confirm message: Message box will appear to confirm to the administrator that a new university record has been saved in the database.

E-3: wrong user id: This message will appear in case the administrator entered the wrong university id; the administrator can reenter the university id.

E-4: confirm message: This message box will appear to confirm to the administrator that the university record has been deleted from the database.

E-5: wrong user id: This message will appear in case the administrator entered the wrong university id; the administrator can re-enter the university id.

E-6: confirm message: This message box will appear to confirm to the administrator that the university record has been updated in the database.

- **Post -Condition**

- The user will be able to add new university records, delete university records, and update university records again.

- **Constraints**

Add new university record will be for the administrator only.

➤ **Use case: Manage Web Information**

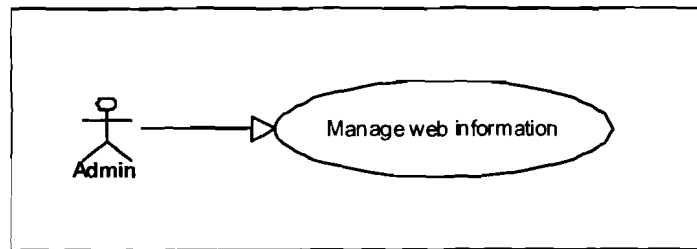


Figure 4.7: Use Case Manage Web Information

▪ **Brief Description**

This use case is initiated by the administrator. This use case will enable the administrator to manage web data.

▪ **Pre-Condition**

The user is already logged in to the system as an administrator.

▪ **Characteristics of Activation**

Event Driven (on user demand).

▪ **Flow of Events**

- This use case is initialized by the administrator when they press the <Manage web information> button; a new page will appear so they can add new information.

▪ **Post-Condition**

- The system must update the information.
- The user will be able to add courses, delete courses and update courses.

➤ **Use Case: Log-Out**

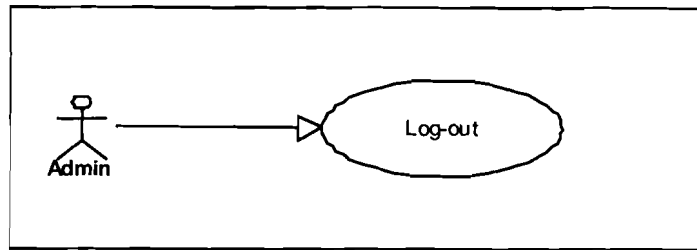


Figure 4.8: Use Case Log-Out

- **Brief description**

This use case is initiated by the user administrator. This use case will enable the user to log out of the system

- **Pre-Condition**

The user is already logged in.

- **Characteristics of Activation**

Event Driven (on user demand)

- **Flow of Events**

This use case begins when the user presses the logout button. The system will display the main page.

- **Post-Condition**

The system will display the main page.

4.2.2.2 Activity Diagram

An activity diagram is essentially a imaginary flowchart, which focuses on the flow of activities involved in a single process, to show how those activities depend on one another. The activity diagram shapes are shown in Figure 4.9 below.

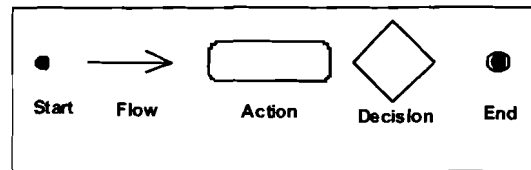


Figure 4.9: Activity diagram shapes

4.2.2.2.1 DSS Search Engine Activity Diagram

A DSS Search Engine Activity Diagram, which is shown in Figure 4.10, explains the flow of student activities, which are insert search criteria for search, viewing the search results and viewing university information.

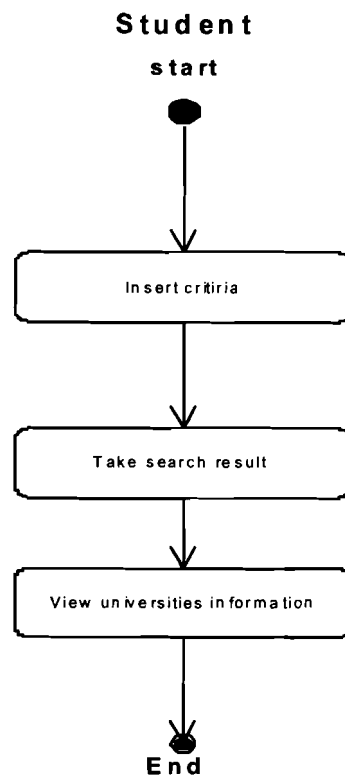


Figure 4.10: DSS Search Engine Activity Diagram

4.2.2.2.2 System Log-in Activity Diagram

The system log-in activity diagram, which is shown in Figure 4.11, explains the flow of Admin Log-in activities, which are entering and checking the user name and password to allow or not allow the user to use his/her authority in the system.

System Administrator

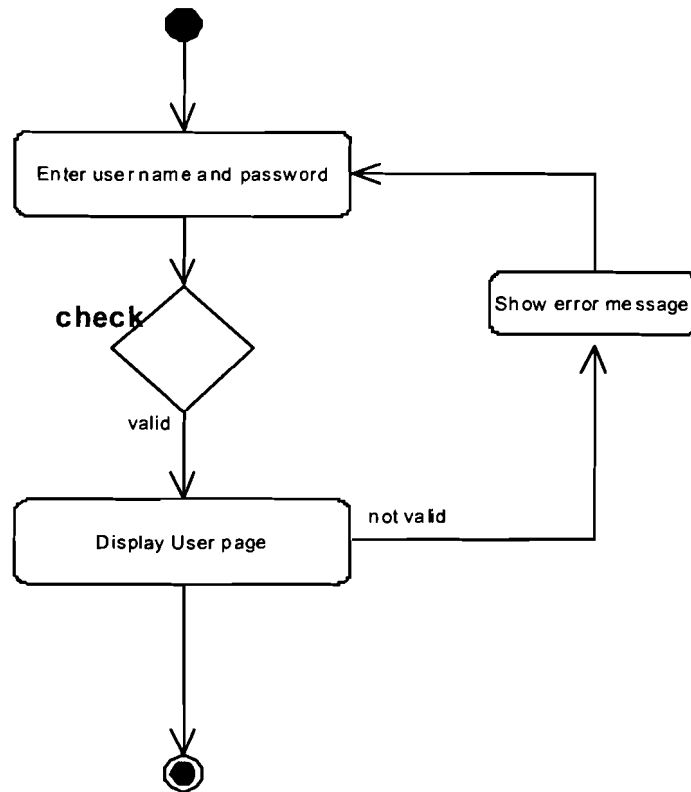


Figure 4.11: System log-in Activity Diagram

4.2.2.2.3 Manage Universities Information Activity Diagram

The Manage Universities Information Activity Diagram, which is shown in Figure 4.12, explains the flow of Manage Universities Information activities by the Administrator, which is to insert new university records, delete records and update records.

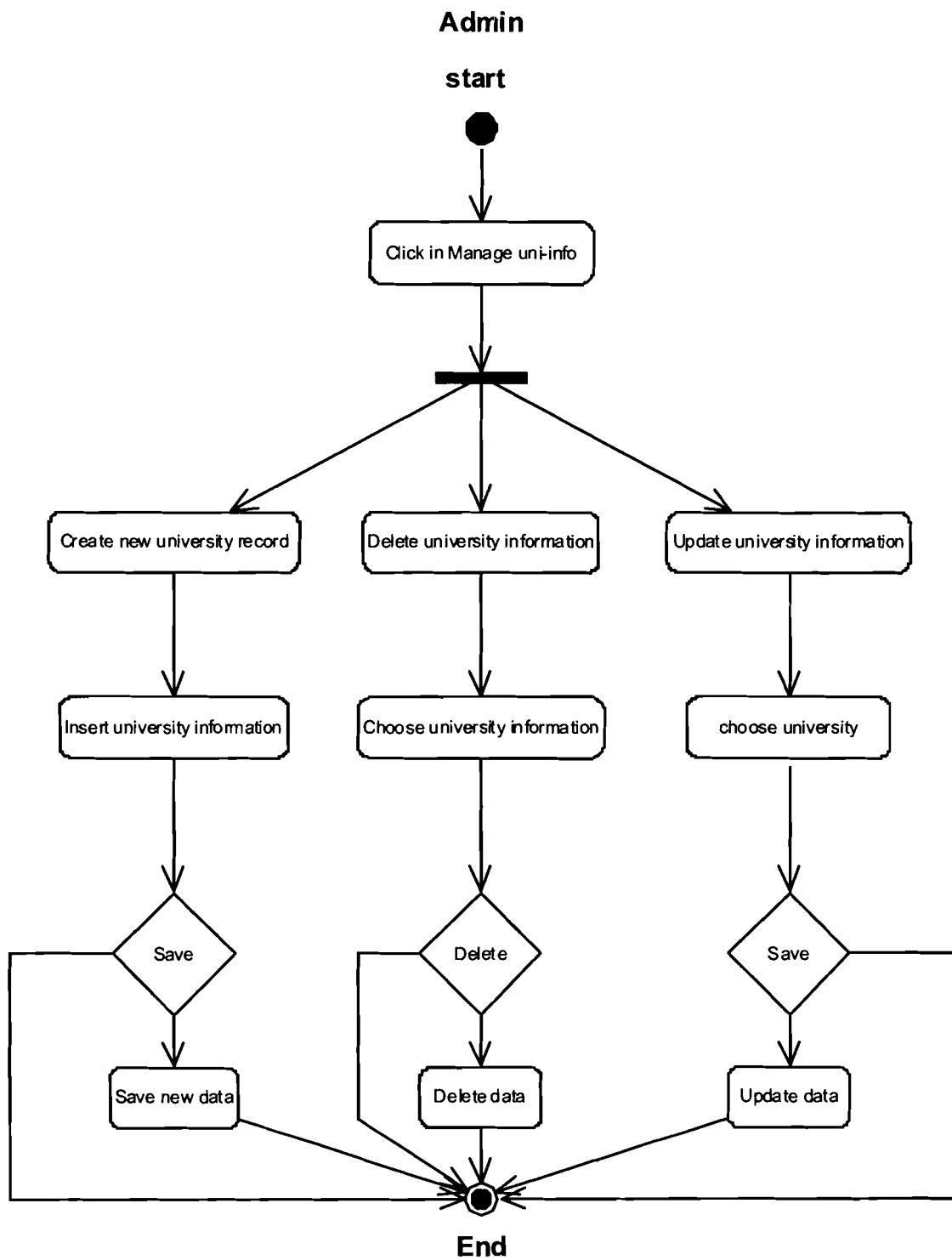


Figure 4.12: Manage University Information Activity Diagram

4.2.2.2.4 Manage Course Information Activity Diagram

Manage Course Information Activity Diagram, which is showing in Figure 4.13 explain the flow of Manage Course Information activities by Admin, which is create new Course record, delete record and update record.

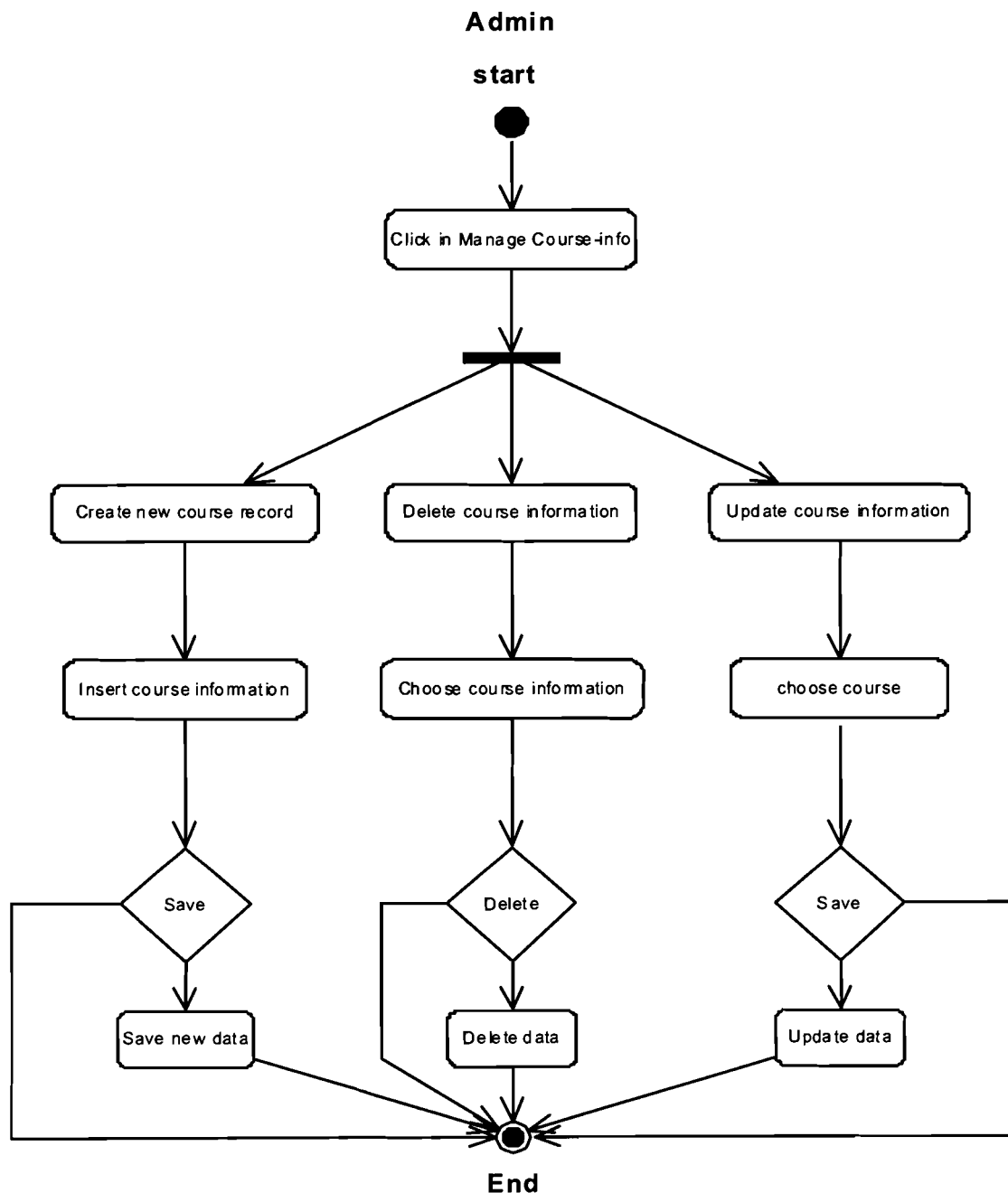


Figure 4.13: Manage Course Information Activity Diagram

4.2.2.3 Sequence Diagram

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams

4.2.2.3.1 System Login Sequence Diagram

The system log-in sequence diagram, which is shown in Figure 4.14, explains the flow of the Admin Log-in sequence, which is entering and checking the user name and password to allow or not allow the user to use his/her authority in the system.

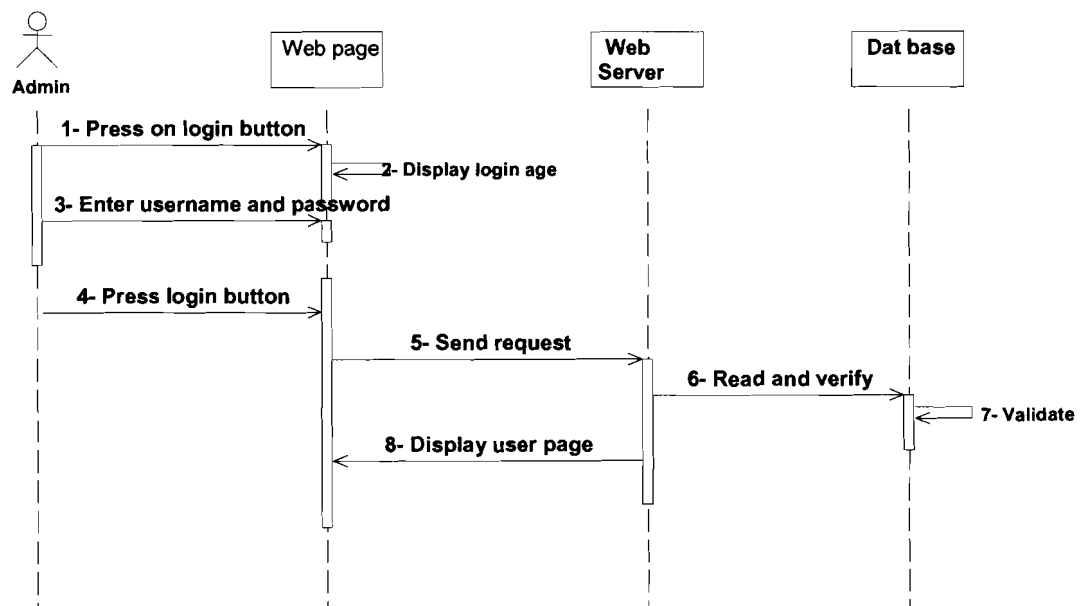


Figure 4.14: System Login Sequence Diagram

4.2.2.3.2 Manage Universities Information Sequence Diagram

The Manage Universities Information Sequence Diagram, which is shown in Figure 4.15 for creating, Figure 4.16 for updating and Figure 4.17 for deleting, explains the flow of Manage Universities Information Sequence by the Administrator, which is creating new university records, deleting records and updating records.

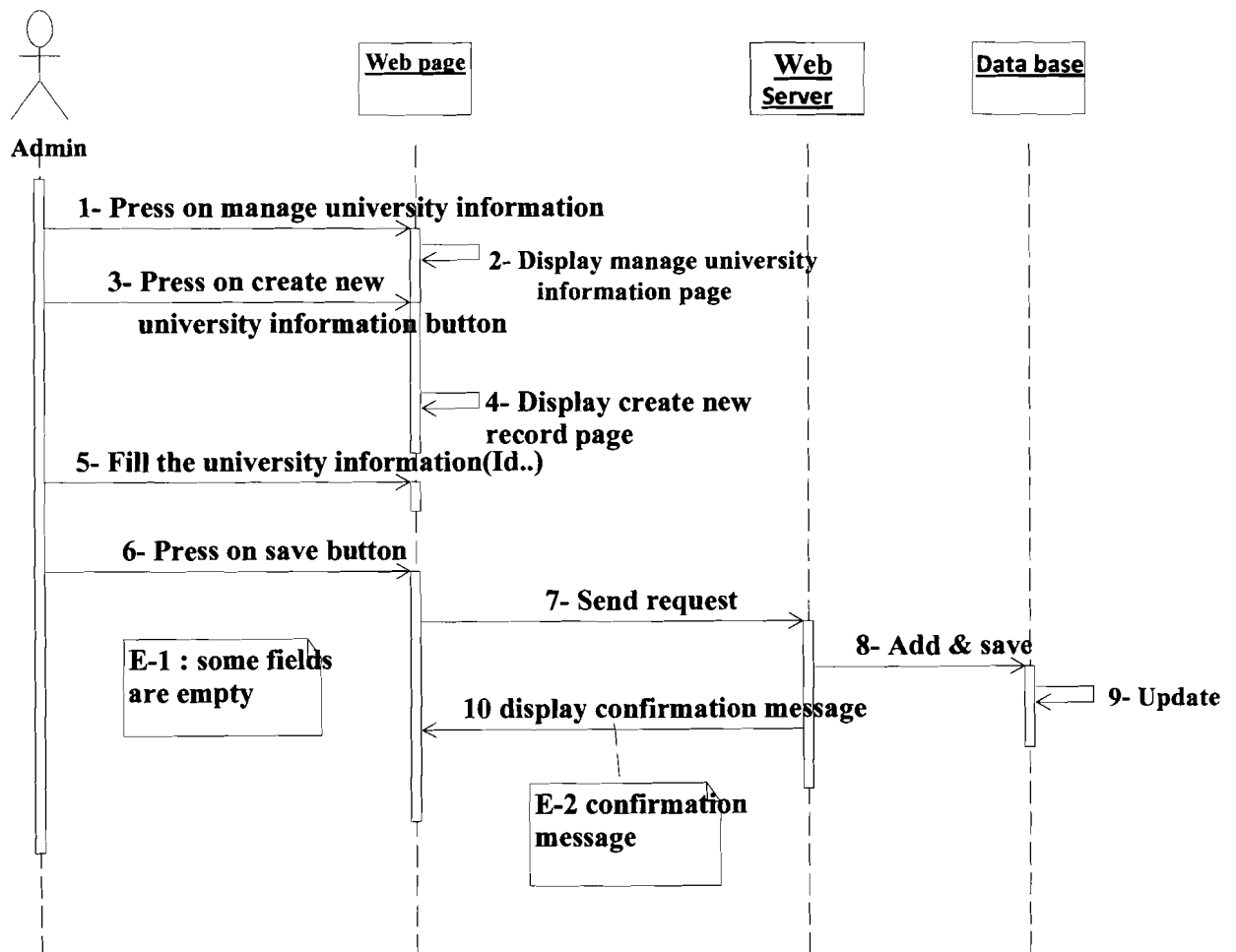


Figure 4.15: Insert New University Information Sequence Diagram

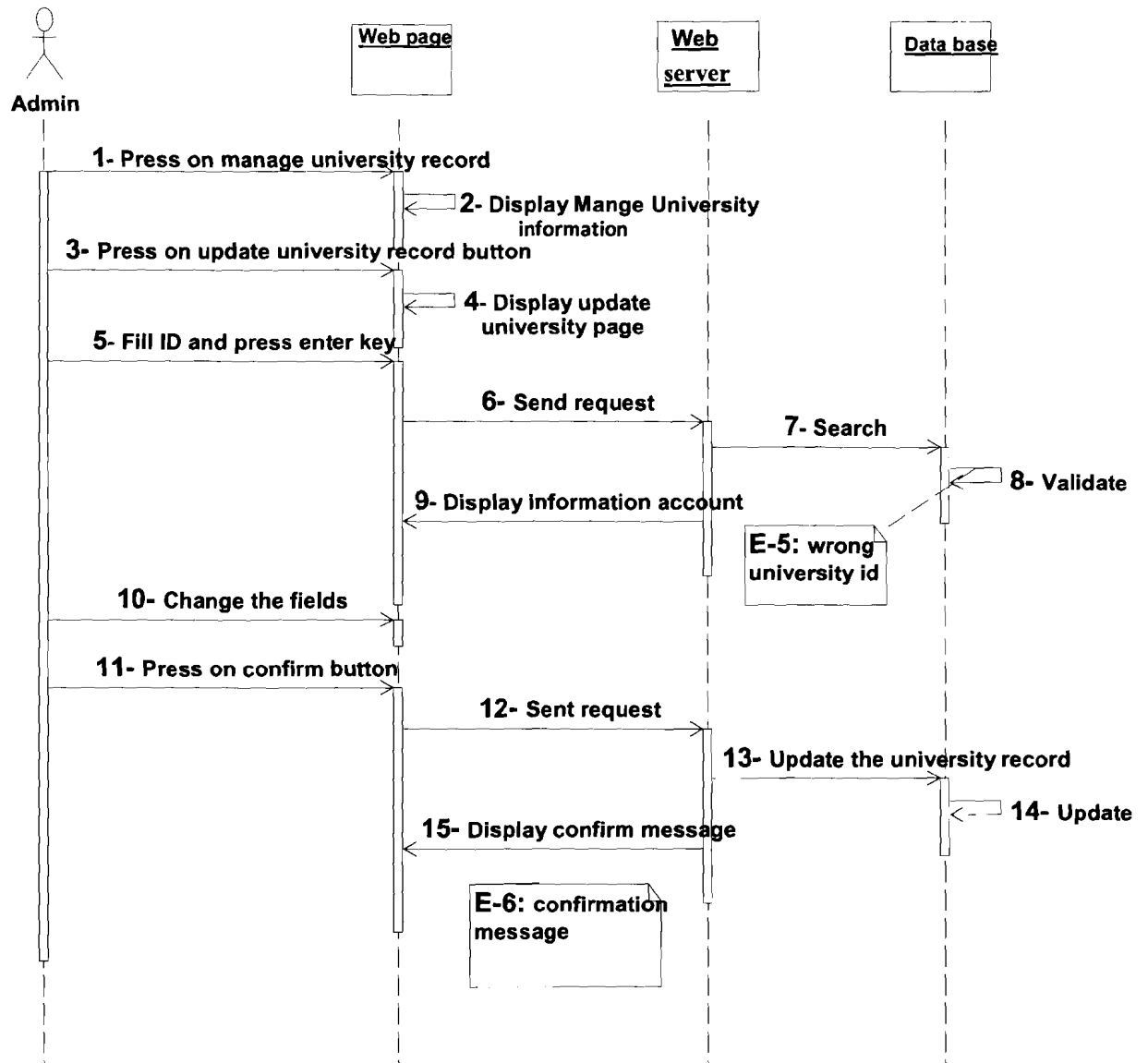


Figure 4.16: Update University Information Sequence Diagram

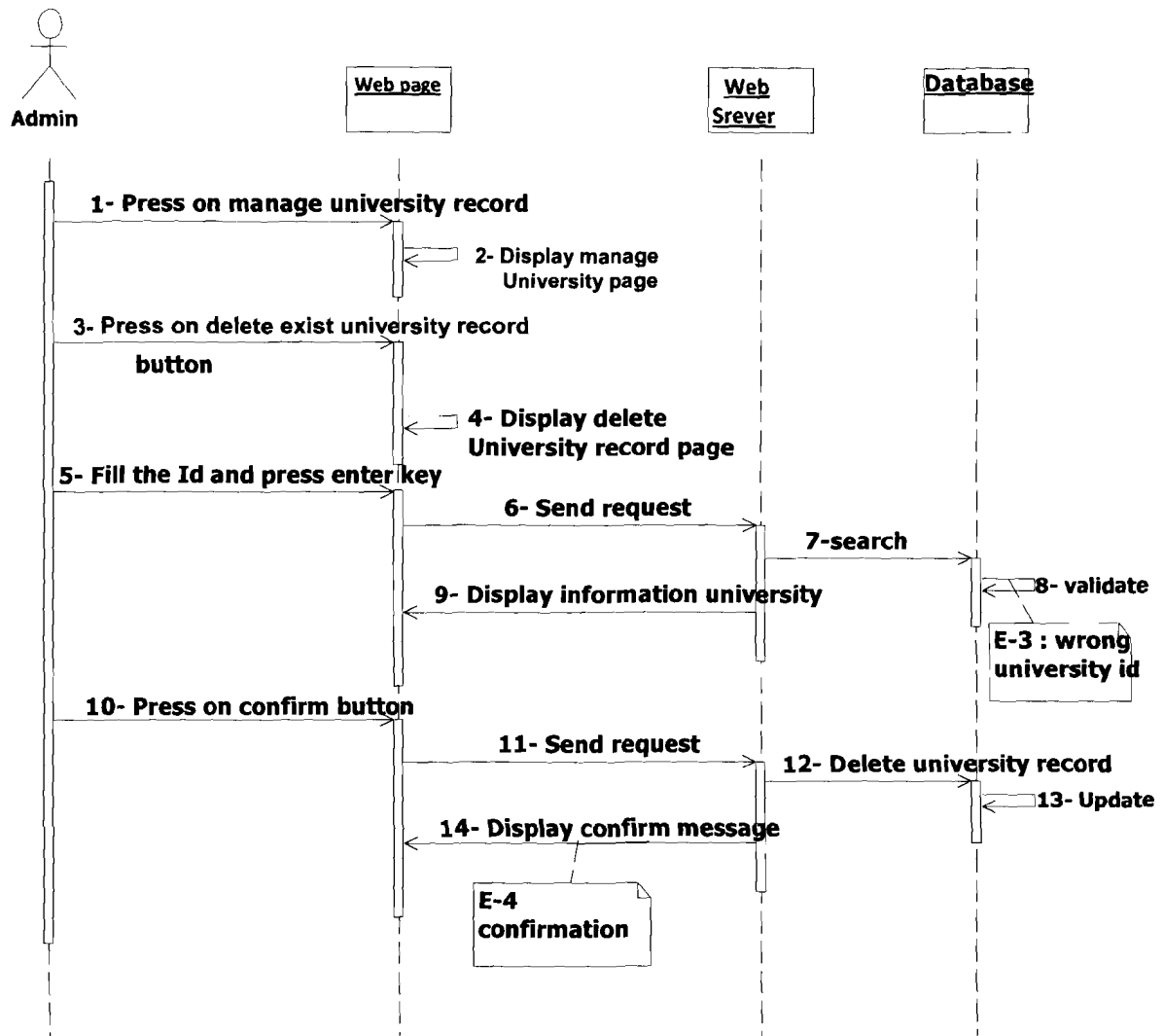


Figure 4.17: Delete University Information Sequence Diagram

4.2.2.3.3 Manage Universities Information Sequence Diagram

The Manage Course Information Sequence Diagram, which is shown in Figure 4.18 for creating, Figure 4.19 for updating, and Figure 4.20 for deleting, explains the flow of the Manage Course Information Sequence by the Administrator, which is creating new courses, deleting courses and updating courses.

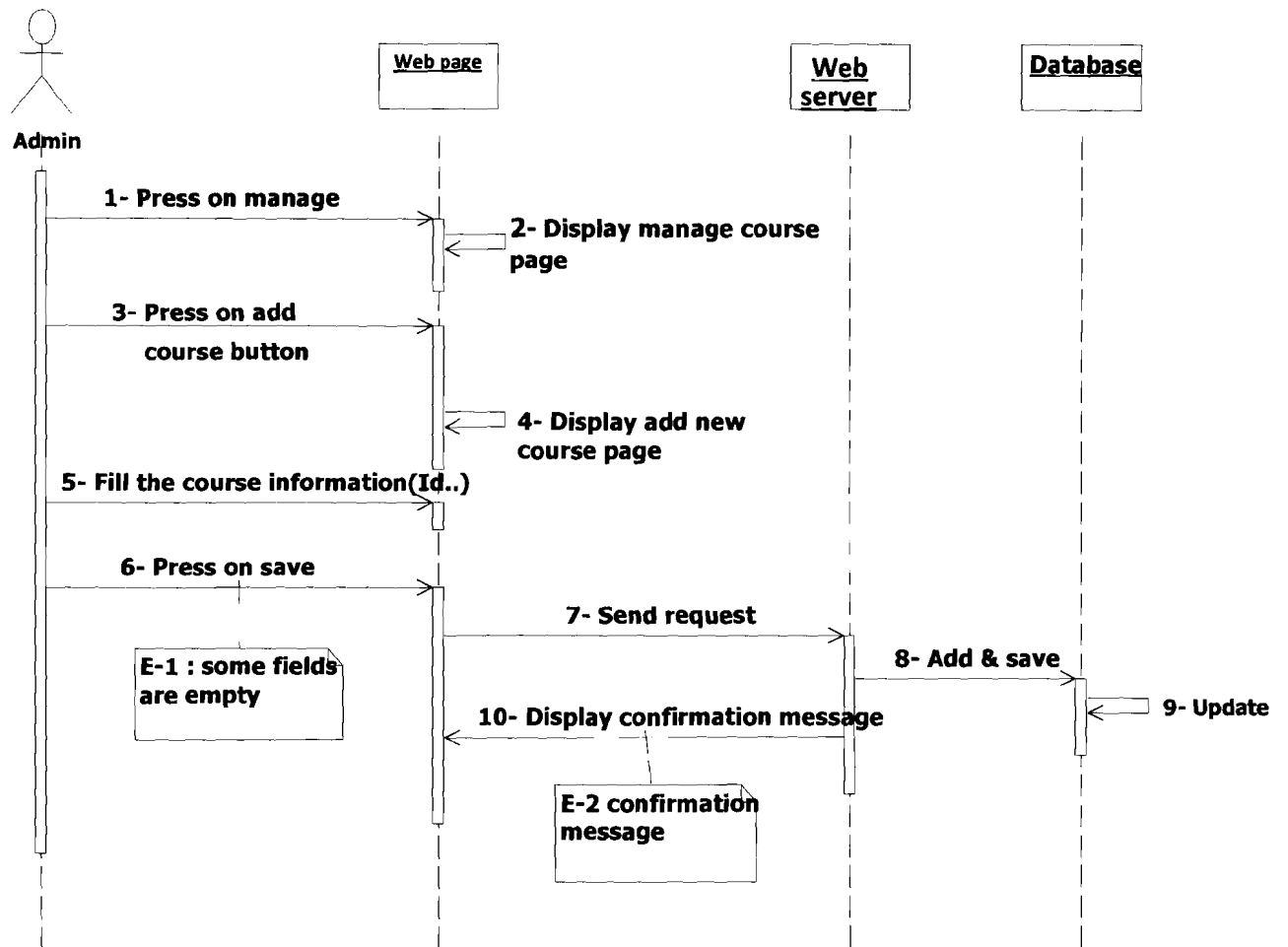


Figure 4.18: Create New Course Information Sequence Diagram

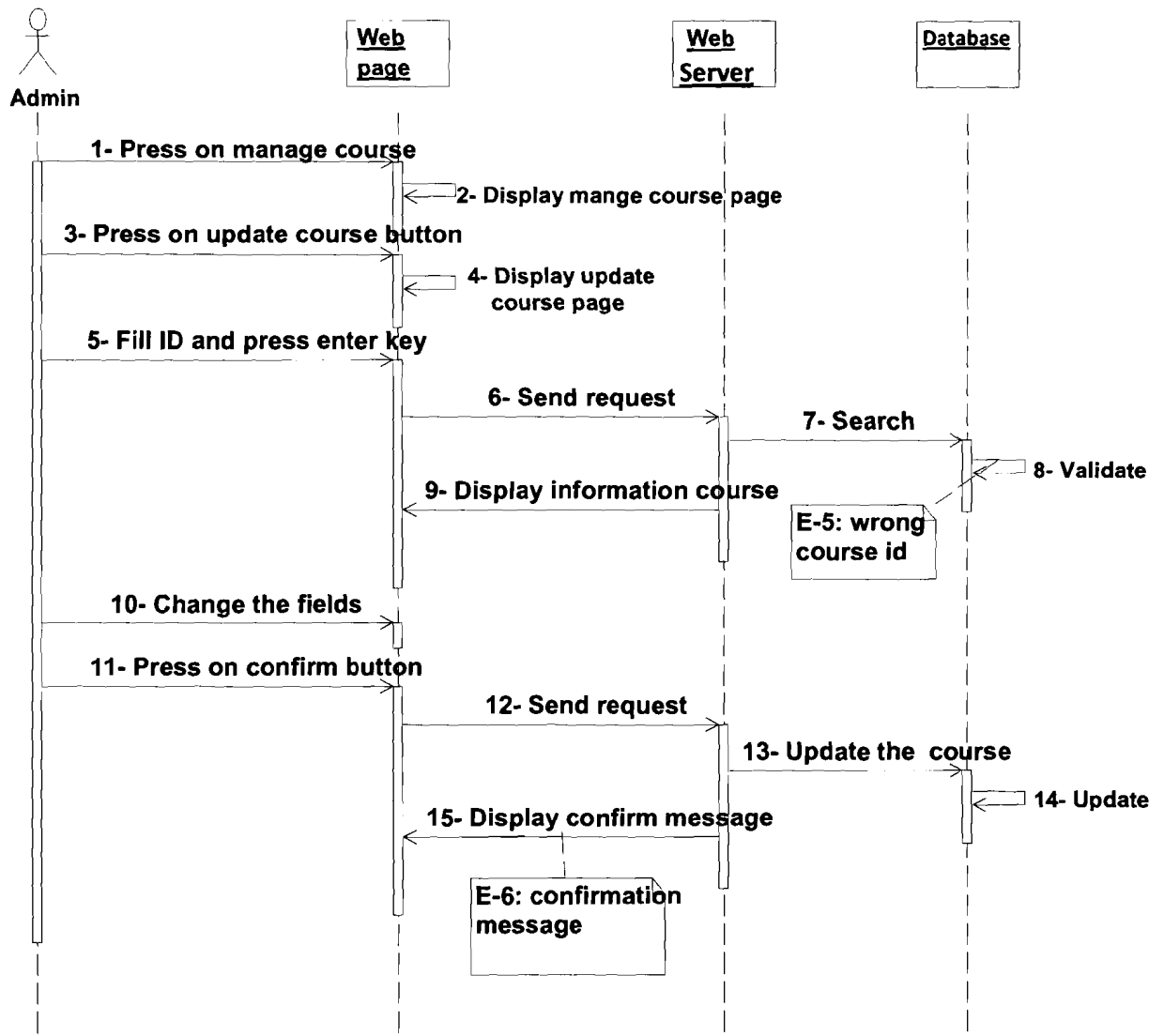


Figure 4.19: Update Course Information Sequence Diagram

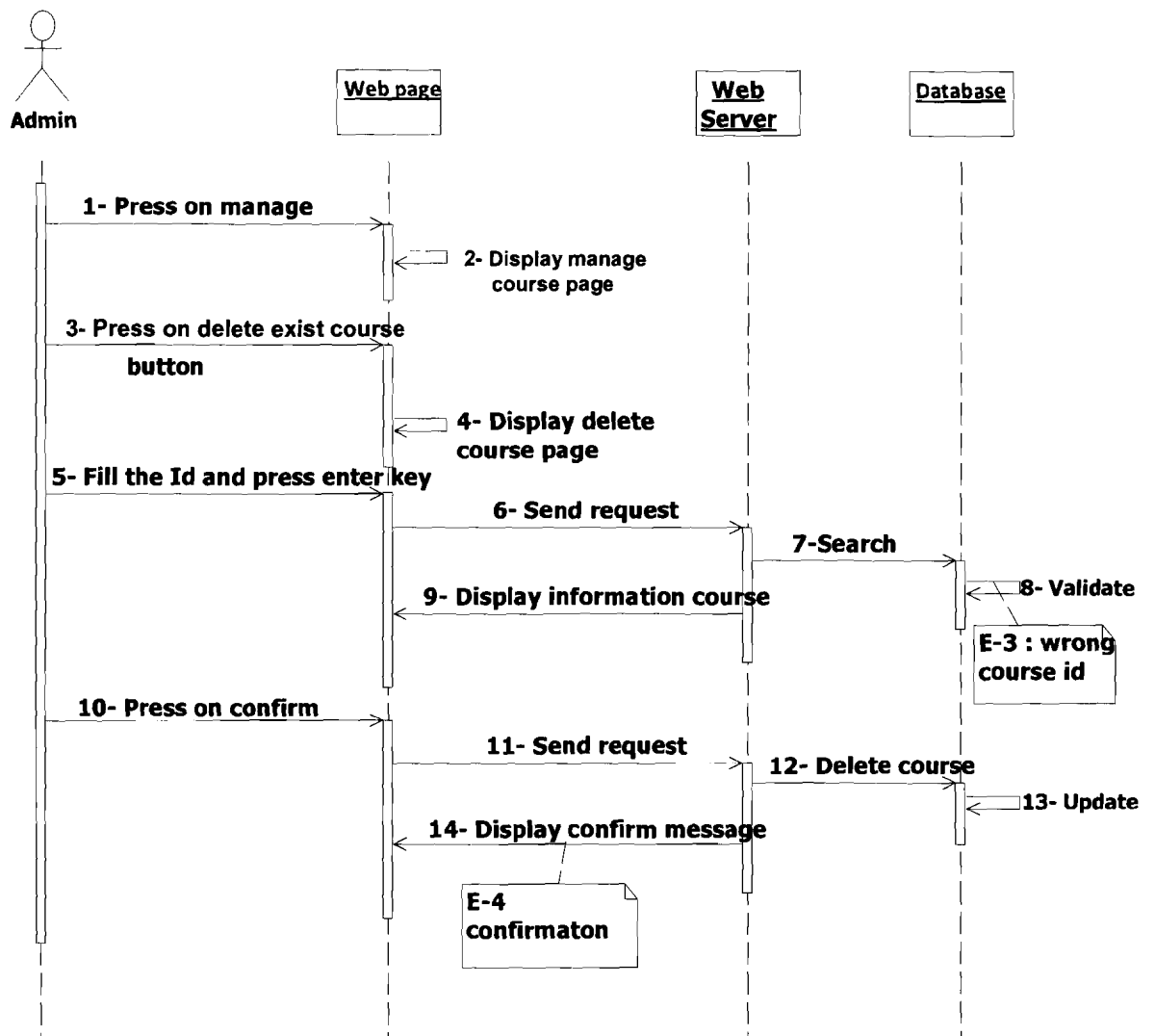


Figure 4.20: Delete Course Information Sequence Diagram

4.2.2.3.4 DSS Search Engine Sequence Diagram

A DSS Search Engine Sequence Diagram, which is shown in Figure 4.21, explains the flow of student sequences, which is insert search criteria for search, viewing the search results and viewing university information.

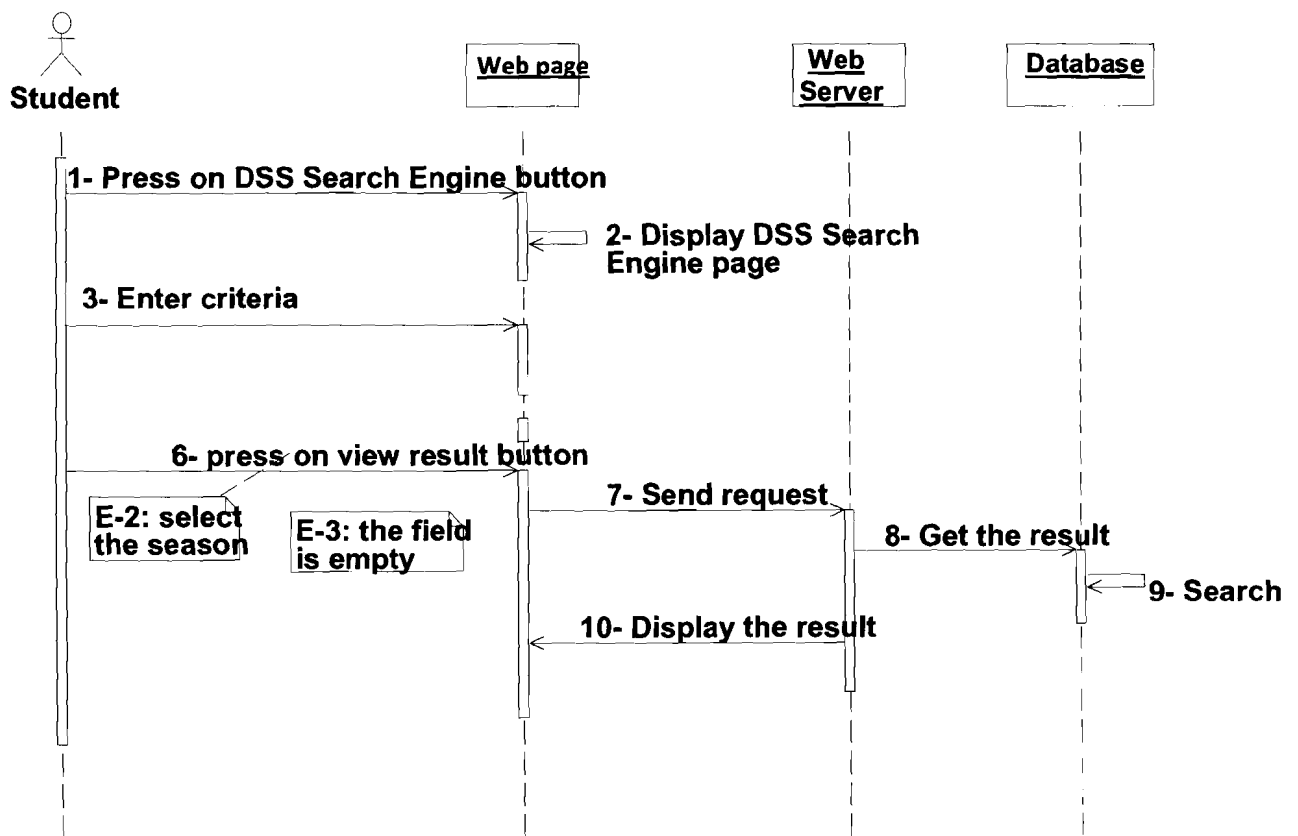


Figure 4.21: DSS Search Engine Sequence Diagram

4.2.2.4 Class Diagram

A Class Diagram is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or) methods and the relationships between the classes. The diagram in Figure 4.22 below shows the Class Diagram for Choosing Malaysian public universities by using preference query techniques (Web-based DSS).

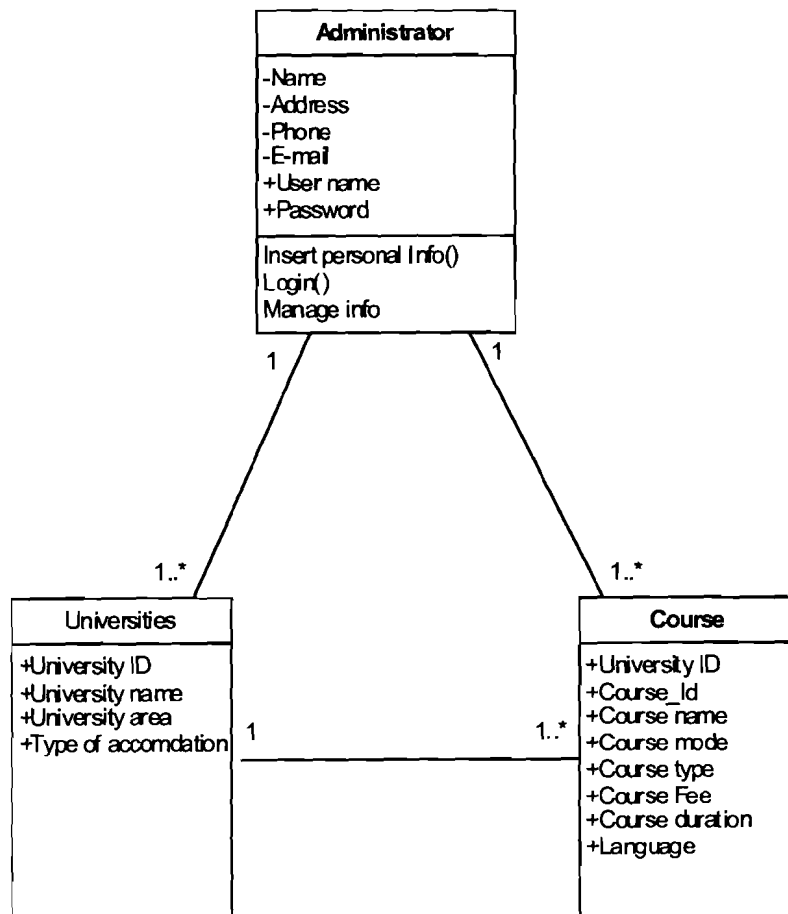


Figure 4.22: Class Diagram of Choosing Malaysian Public Universities

4.3 Implementation of DSS Prototype

An implementation is a realization of a technical specification or algorithm as a program, web-based application, or other computer system through programming and deployment. Many implementations may exist for a given specification or standard. In the implementation phase, we deployed the DSS Prototype by using a Java server page (JSP) for web page programming and MYSQL for the database development.

4.3.1 Main Page and Login Interface

The main page contains the main information and web-site address for Malaysian public universities. Also on the main page the administrator can login to the system. In the interface in Figure 4.23, the administrator can enter his/her user name and password (admin,1234) to login to the system, which checks the user name and password to allow or not allow the administrator to use his/her authority in the system

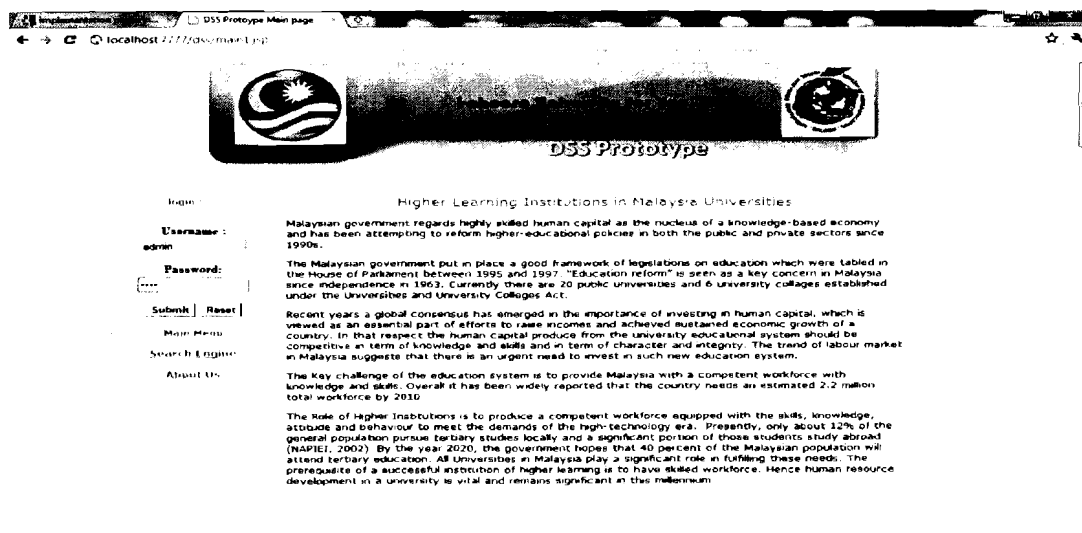


Figure 4.23: Main Page and Login Interface

4.3.2 Administrator Main Interface

On this page the administrator can manage university information, such as insert university information, update university information, view university information and delete university information. This is shown in Figure 4.24.

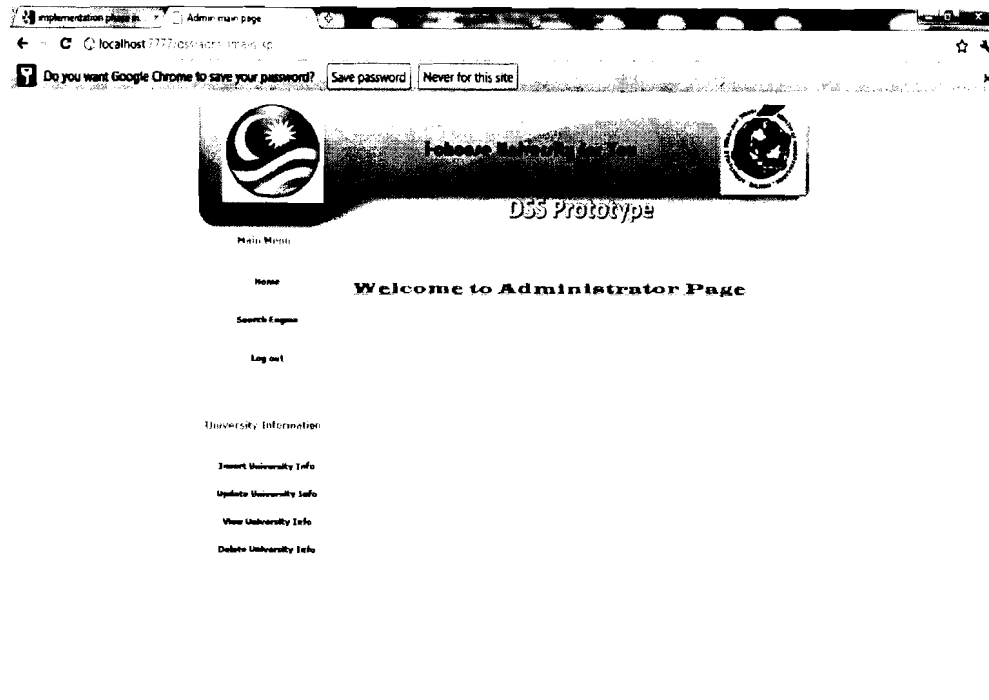


Figure 4.24: Admin Main Interface

4.3.2.1 Insert University Information Interface

In this page the administrator can insert university information, for example: university name is University Utara Malaysia, university area is Rural area, course name is Law, course mode is Full time, course type is PhD, course fee is 23000 RM, course duration is 3 years, course language is English and university web site is <http://www.uum.edu.my>, which is shown in Figure 4.25. If the administrator clicks on the add button, a new interface will appear and tell the administrator that he/she was successful in inserting data to the database, which is shown in Figure 4.26.

University ID:	
University Name:	University Utara Malaysia
University Area:	Rural area
Course Name:	Law
Course Mode:	Full time
Course Type:	Phd
Course Fee:	23000
Course Duration:	3
Course Language:	English
University Web Site:	http://www.uum.edu.my

Add Reset

Figure 4.25: Insert University Information Interface

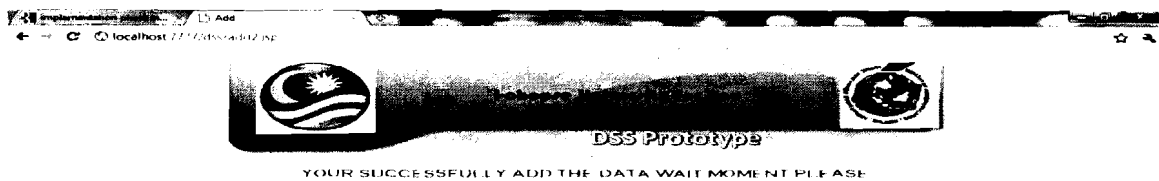


Figure 4.26: Insert University Information Confirmation Interface

4.3.2.2 Update University Information Interface

On this page the administrator can update university information, for example: change university name from University Malaysia to University Malaya, university area from Rural area to City, course fee from 23000 to 28000 RM, course duration from 3 to 4

years and university web site from <http://www.uum.edu.my> to <http://www.um.ed.my>, which is shown in Figure 4.27. If the administrator clicks on the <update> button, a new interface will appear and tell the administrator that he/she was successful in updating data in the database, which is shown in Figure 4.28.

University ID:	32
University Name:	University Malaysia
University Area:	City
Course Name:	Law
Course Mode:	Full time
Course Type:	Phd
Course Fee:	28000
Course Duration:	4
Course Language :	English
University Web Site:	http://www.um.edu.my

Figure 4.27: Update University Information Interface

YOUR SUCCESSFULLY UPDATE THE DATA WAIT MOMENT PLEASE

Figure 4.28: Update University Information Confirmation Interface

4.3.2.3 Delete University Information Interface

On this page the administrator can delete university information, for example: choose the university information they want to delete by choosing university ID :32, which is shown in Figure 4.29. If the administrator clicks on the delete button, a new interface will appear and tell the administrator that he/she was successful in updating data in the database, which is shown in Figure 4.30.

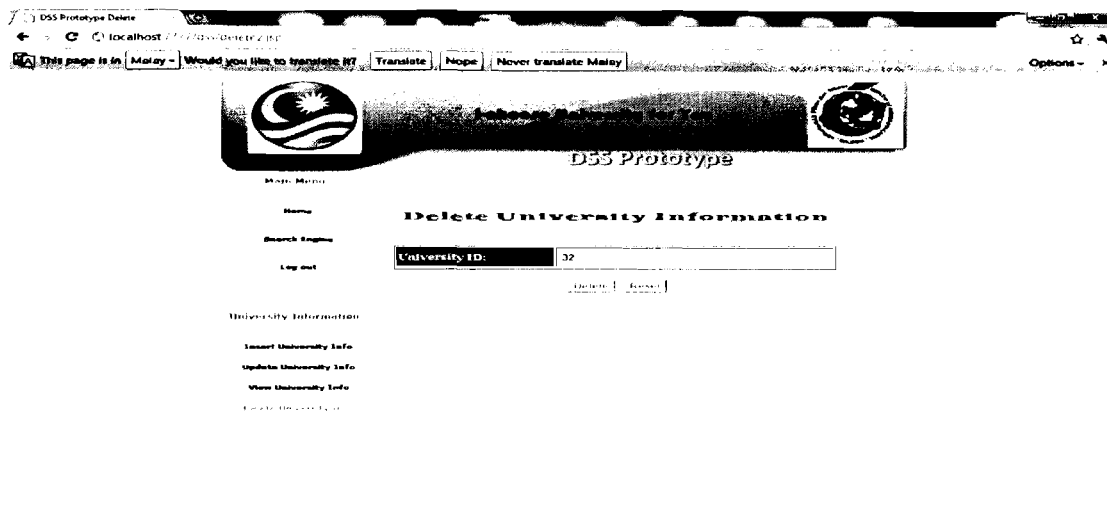


Figure 4.29: Delete University Information Interface

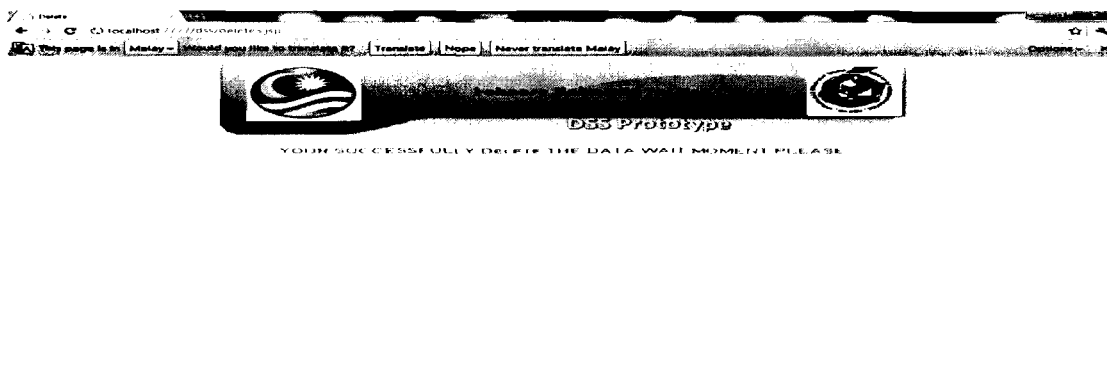


Figure 4.30: Delete University Information Confirmation Interface

4.3.3 Search Engine Interface based on Student Criteria

The international students can open the DSS prototype main page and choose the search engine link to insert their criteria through the search engine interface and the system gives them the results for the suggested university. The student criteria in DSS prototype are course name, course type (PhD, Master, or Degree), course mode (Fulltime or Part time), course fee (Ringgit Malaysia), course duration (years), course language (English, Malay or Mix), university area (Rural area or City) and university accommodation types (Double bed room, Single bed room or Apartments).

In the DSS prototype database, we inserted all the Malaysian public universities information for Information Technology Courses for PhD and Masters and Management Courses for undergraduates. In section 4.3.3.1 we searched for PhD, in 4.3.3.2 we searched for Masters and in 4.3.3.3 we search for degrees with different criteria in each search.

4.3.3.1 Search Engine for PhD and Suggested Universities Interfaces

PhD International students can insert data based on their criteria, for PhD students. For example, they can insert Information Technology for the course name, PhD for course type, Full time for course mode, 30000 RM for course fee, 5 years for course duration, English for course language, City for university area and Double bedroom for university accommodation, which is shown in Figure 4.31.

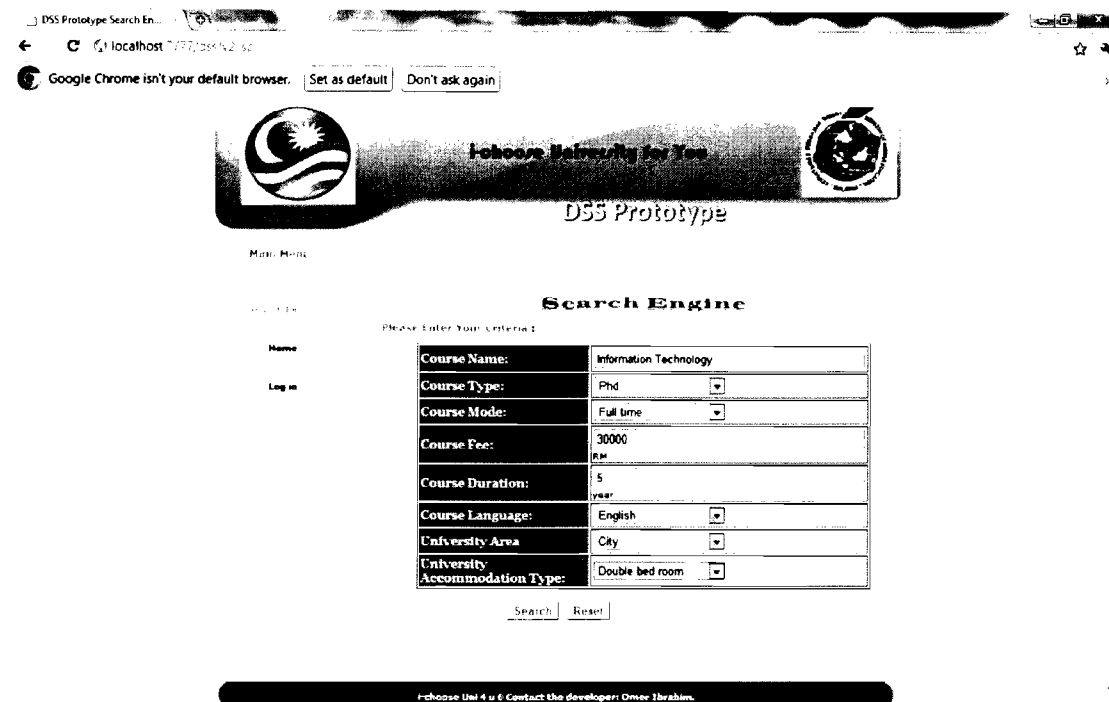


Figure 4.31: Search by PhD students Based on Certain Criteria

In the suggested universities page shown in Figure 4.32, we obtained two universities in order with matching criteria with lower fees, which are University Malaysia Terengganu and International Islamic University Malaysia. These universities are suitable universities that matched the criteria that we inserted. If the user wants to view all the information about these suggested universities they can click on the display button. In our case, we showed university information about University Malaysia Terengganu, which is shown in Figure 4.33.

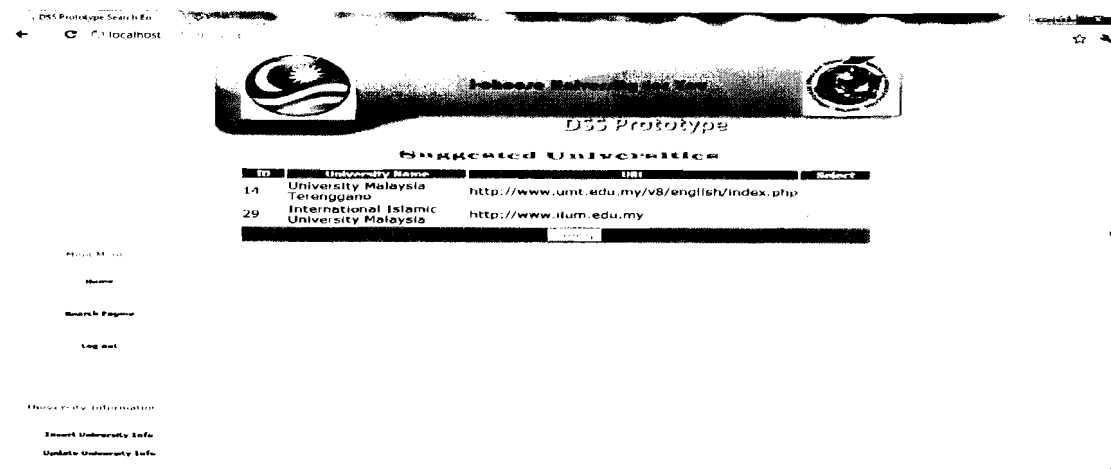


Figure 4.32: Suggested Universities Interface

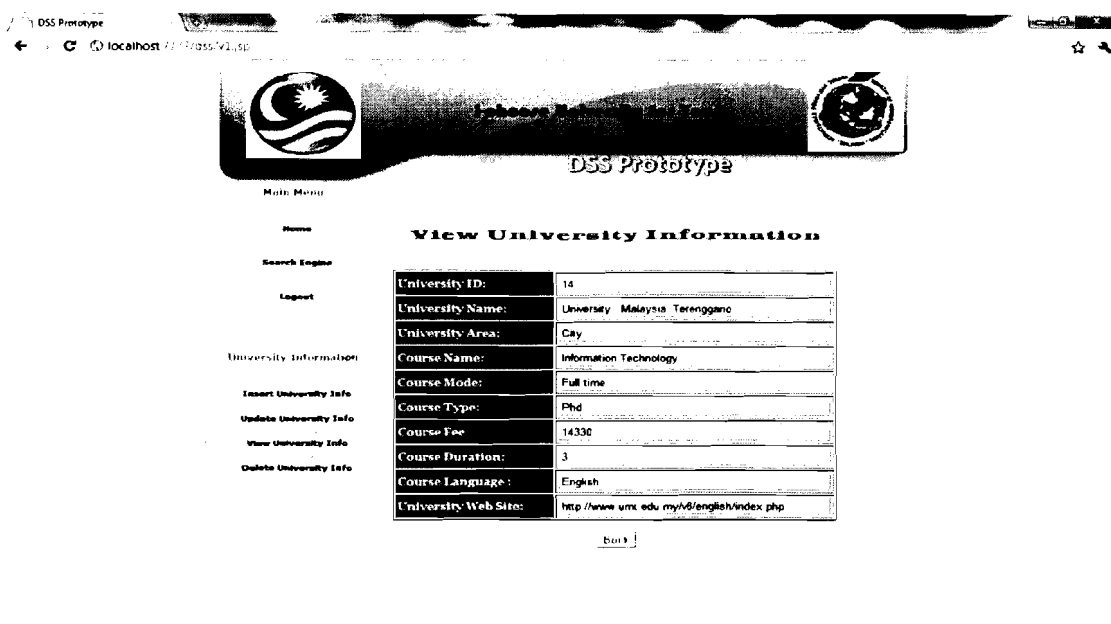


Figure 4.33: Suggested University Information Interface

4.3.3.2 Search Engine for Master Degree and Suggested Universities Interfaces

Master degree International students can insert data based on their criteria. For example, they can insert Information Technology for the course name, Master for the course type, Full time for the course mode, RM 20000 for the course fee, 2 years for

the course duration, English for course language, Rural area for university area and Apartments for university accommodation, which is shown in Figure 4.34.

Search Engine

Please Enter Your Criteria :

Course Name:	Information Technology
Course Type:	Master
Course Mode:	Full time
Course Fee:	20000 RM
Course Duration:	2 year
Course Language:	English
University Area:	Rural area
University Accommodation Type:	Apartments

I choose Uni 4 u.s Contact the developer: Omer Ibrahim.

Figure 4.34: Search by Master Students Based on Certain Criteria

On the suggested universities page, which is shown in Figure 4.35, we got three suggested universities in order with matching criteria with lower fees, which were University Malaysia Pahang, University Pendidikan Sultan Idris and University Technology Malaysia in order. These universities are suitable universities that matched the criteria that we inserted. If the user wants to view all information about these suggested universities they can click on the display button. In our case we showed university information about University Malaysia Pahang, which is shown in Figure 4.36.

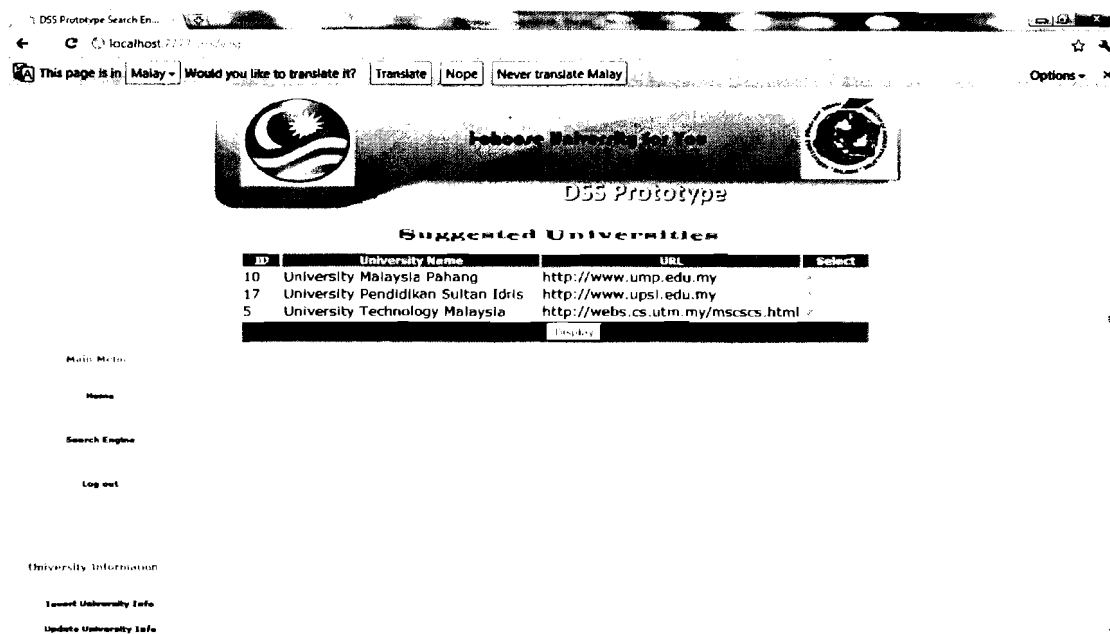


Figure 4.35: Suggested Universities Interface

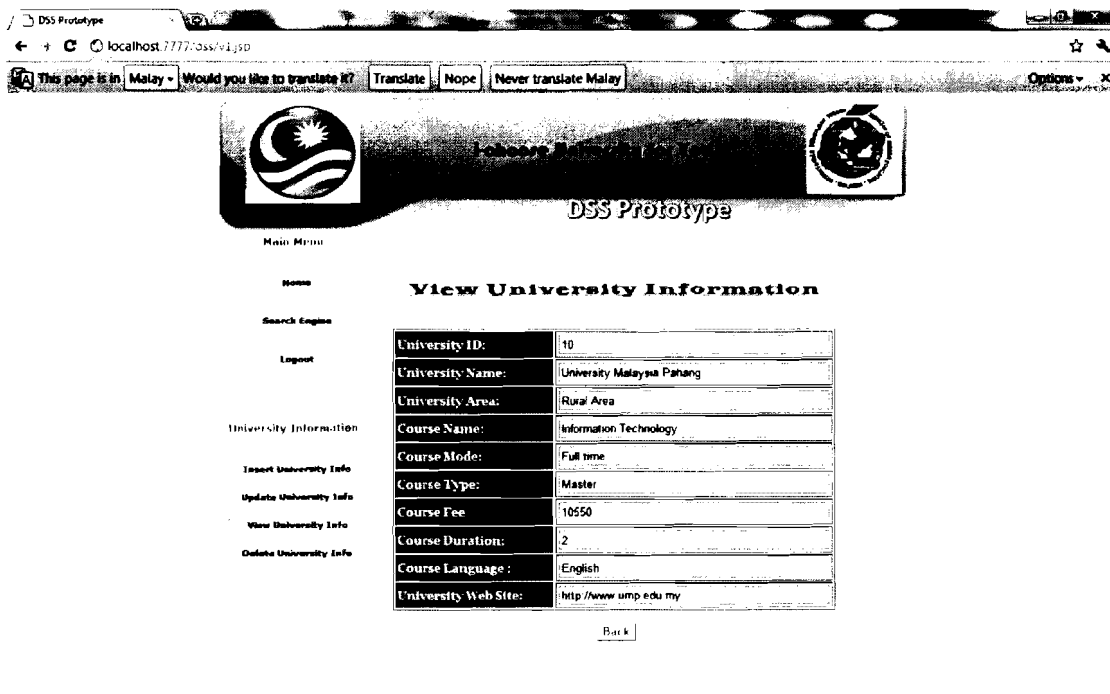


Figure 4.36: Suggested University Information Interface

4.3.3.3 Search Engine for Undergraduate and Suggested Universities Interfaces

Undergraduate International students can insert data based on their criteria. For example, they can insert Management for the course name, Degree for the course type, Full time for the course mode, RM 28000 for the course fee, 4 years for the course duration, Mixed for the course language, Rural area for university area and Double bedroom for university accommodation, which is shown in Figure 4.37.

Figure 4.37: Search by Degree Students Based on Certain Criteria

On the suggested universities page, shown in Figure 4.38, we got four suggested universities in order with matching criteria with lower fees, which are University Utara Malaysia, University Sains Malaysia, University Technology Malaysia and University Pendidikan Sultan Idris. These universities are suitable universities that

matched the criteria that we inserted. If the user wants to view all information about these suggested universities they can click on the display button. In our case, we showed university information about University Utara Malaysia, which is shown in Figure 4.39.

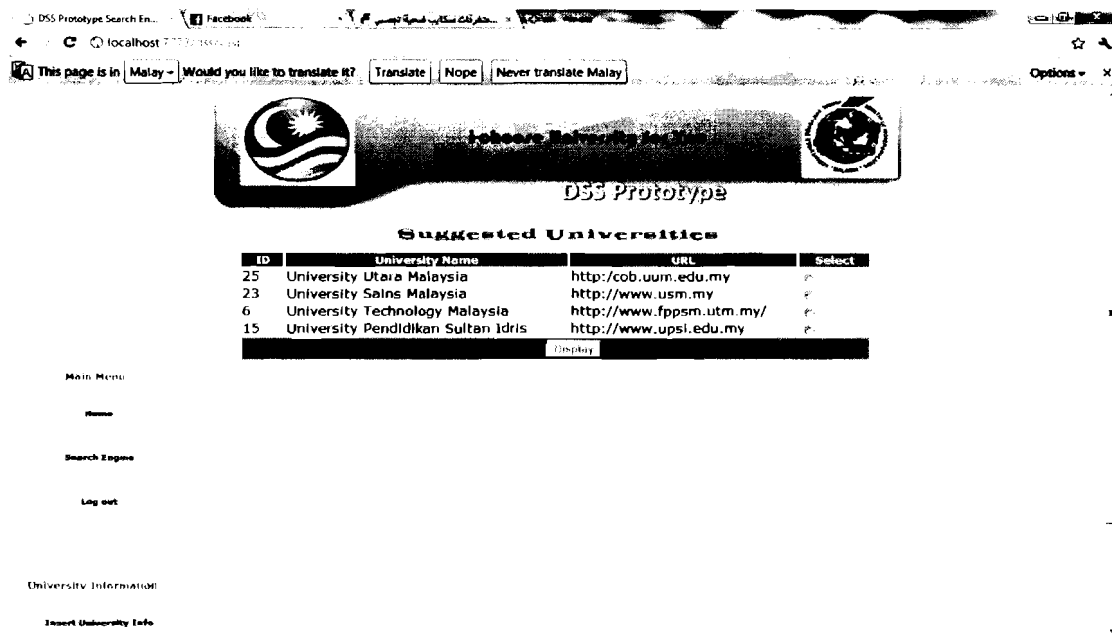


Figure 4.38: Suggested Universities Interface

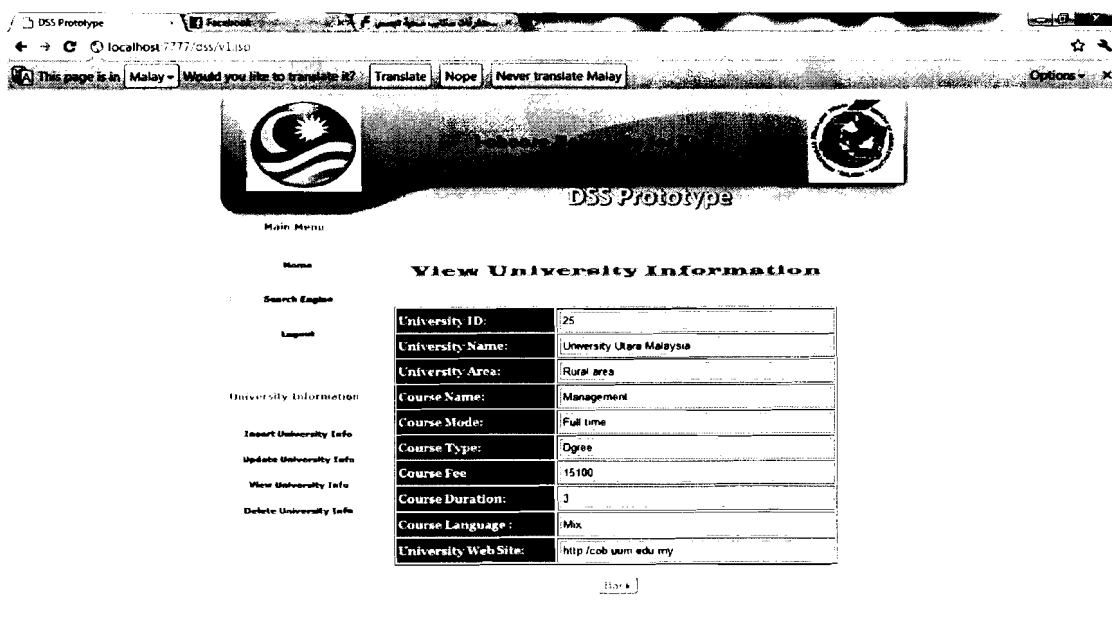


Figure 4.39: Suggested University Information Interface

4.4 Summary

This chapter describes Analysis and design of DSS prototype. In design, we used UML. Moreover, the chapter also explains the implementation of the DSS prototype.

CHAPTER FIVE

CONCLUSIONS AND FUTURE WORK

In the previous chapters we have discussed the introduction, literature review, methodology, analysis, design and implementation of this thesis. Therefore, this chapter concludes the whole thesis, which presented a conclusion and limitations of the study. Moreover, future works are also presented in this chapter.

5.1 Conclusion of the study

Earlier we discussed the wrong decision in choosing a university and its consequences for a student's future. Malaysia tries to attract international students to study in its universities. Many researchers simplified the reasons for many international students in Malaysia terminating their studies because of a wrong decision in choosing a university. Therefore, the international students who want to study in Malaysia need a richness of information to help them in choosing the right university based on their criteria. According to this we set up the problem statement. And based on that problem, we set out the objective, which is developing a web-based DSS prototype for choosing public universities in Malaysia by using preference query techniques. Also we set out the scope and significance of the study.

After clarifying the problem, we examined relevant previous studies on, first, a decision support system (DSS) to make the MOHE interactive with international students and give them enough information about public universities and help them

to make the right decision. Second, preference query techniques, which have been considered as a mechanism to let international students choosing public universities in Malaysia based on their criteria.

Moreover, we explained the rapid application development (RAD) method that was used to develop the Web-based DSS prototype. We also explained DSS architecture. Furthermore, both of the RAD methods for DSS architecture were used to solve the research problem and achieve the aims of this study.

The implementation of the Web-based DSS prototype in this research was conducted by using JSP and MYSQL (open sources software). As we explained DSS prototype suggests to international students at maximum five universities that are most suitable to students based on student's criteria which insert by them.

5.2 Limitations of the study

The main limitation of this study is preference SQL, because there is no commercial or student version. Because of this, we translated a skyline query to a Nested SQL Query. Moreover, we faced problems in data collected for testing the DSS prototype, because obtaining real data from the international students and Malaysian public universities was difficult.

5.3 Recommendation

The web-based DSS prototype has been developed and tested on a localhost server. Thus, the test of its true performance cannot due to limited financial budget. There are several recommendations on the study as follows:

1. The web-based DSS prototype should be uploaded in web server to get real performance of the system.
2. The web-base DSS database should include all public and private universities in Malaysia to make it easy for international students when they want to study in Malaysia.
3. The web-based DSS should be upgraded with more useful and beneficial functions.
4. In DSS search engine should add more criteria to help international students to choose suitable universities according to their criteria.

5.4 Future Work

Based on the achievement of this study, the researcher suggests that future researchers who would like to work on preference query techniques to conduct web-base DSS by using other type of on preference query techniques such as top-k and top-k Dominating queries. Also can measure the performance of skyline query and compare it other type of preference query Techniques.

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